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INTRODUCTION

Bees of all kinds belong to the order of insects known as Hymenoptera, literally "membrane wings". This order, comprising some 100,000 species, also includes wasps, ants, ichneumons and sawflies. Of the 25,000 or more described species of bees, the majority are solitary bees most of which lay their eggs in tunnels, which they excavate themselves. In some species small numbers of females may share a single tunnel system, and in other cases there may be a semi/social organization involving a hierarchical order among the females, these bees provide a supply of food (honey and pollen) for the larvae, but there is no progressive feeding of the larvae by the adult bees.

Honeybees belong to the family of social bees which includes bumble bees and the tropical stingless bees of the genus Meliponinae. The social bees nest in colonies headed by a single fertile female, the queen, which is generally the only egg layer in the colony. Foraging for nectar and other tasks such as feeding the queen and the larvae, cleaning brood cells and removing debris, are carried out by a caste of females, the Workers. Honey and pollen is stored, and larvae are reared in cells made from wax secreted by the worker bees. Typical colonies may amount to no more than a few dozen insects, and may be annual as in the case of bumble bee colonies, or they may number several tens of thousands and persist for a number of years, as in the case of honeybees and species of Meliponinae. The sub-family Apinae or honeybees, comprises a single genus, Apis, which is characterised by the building of vertical combs of hexagonal cells constructed bilaterally from a midrib, using only the wax secreted by the worker bees. The cells are multifunctional, being used repeatedly for rearing the larvae and for the storage of honey and pollen. Progressive feeding of the larvae is carried out by young bees with food produced by glands in the head of the bee from honey and pollen. Two attributes of honeybees which have been essential to their evolution and biology are their clustering behaviour and, particularly in the case of the cavity-nesting species, their ability to cool the nest by evaporation of water collected outside. These attributes enable the colonies to achieve a marked degree of temperature regulation within the nest irrespective of the external temperature. The genus Apis was thus enabled to colonise a wide variety of environments, ranging from tropical to cool temperate. The Meliponinae which lack this capability are confined to tropical regions. Another behavioural character of honeybees is the communication of information about food sources and the recruitment of foragers by "dance language". The accurate dissemination of information concerning direction and distance of forage areas leads to efficient exploitation of food sources. Whereas representatives of most types of bee were indigenous to all the continents, bees belonging to the genus Apis were originally to be found only in the Old World, namely Asia, Africa and Europe. This suggests that the genus appeared much later than the other types. The genus comprises four species: *Apis florea*, the Little Honeybee; *Apis dorsata*, the Giant Honeybee; *Apis cerana*, the Eastern Honeybee; and *Apis mellifera*, the Western Honeybee. (Some authors include *Apis laboriosa* and *Apis andreniformis* as separate species, but it is likely that these are geographical subspecies of *Apis dorsata* and *Apis florea* respectively which show greater physical variations than the other subspecies and are possibly in a more advanced stage of speciation.

BEEKEEPING : A MULTIPLE SOURCE OF INCOME

Benefits of Beekeeping

Beekeeping has both direct and indirect benefits. The direct benefits are the hive products: honey, beeswax, pollen, royal jelly, bee venom, propolis, and bee colonies. These can be consumed to improvea family's nutrition, sold for cash income, or used as a basis for enterprise development, for example cosmetics based on beeswax. The indirect benefits include pollination, which leads both to increased crop productivity and maintenance of natural biodiversity, including sustaining the natural products used by farmers. Beekeeping also generates off-farm employment opportunities in different fields including hive carpentry, production and sale of honeybee colonies, honey trading, renting of bees for pollination, and bee-based micro enterprises. Beekeeping is ideally suited as a means of income generation for a wide range of people with otherwise limited opportunities, including the poorest of the poor, women, and people from disadvantaged groups. It usually needs only a very small start up investment, can be carried out in a small space close to the house, and yields profits within the first year of operation.

- In India farmers have small land holdings. Beekeeping does not used any land, therefore, small holders and even landless people can undertake beekeeping.
- Beekeeping work does not compare with any branch of agriculture.
- Beekeeping does not require continuous labour and thus is good for disguised labour.
- Managing bee colonies does not require heavy physical work, therefore even women and children can maintain bees.
- Heavy investment is not required for beekeeping.
- Beekeeping requires some equipments. This encourages artisans to undertake these jobs.
- Honey is the diet of farmer's family makes the diet more balanced.

Beekeeping is a multiple source of income.

- Beekeeping can occupy an important place in the economy of farmers. Income from honey supplements the main income from crops and subsistence farmer can get a higher income from beekeeping than from all other work.
- Bees wax is the second crop from beekeeping. The wax has commercial and industrial value, especially cosmetic industry.
- Sale of colonies by division is another source of income. Good beekeepers can even sell superior queens raised from better-performing colonies.
- Production of other hive products like royal jelly, bee venom, propolis and pollen can further be the sources of income.
- During nectar and pollen gathering, the honeybees effect pollination and improve the quantity and quality of crop produce. The benefits through pollination and derived by a community rather than only by the beekeeper. Beekeeper himself can increase his income by renting out his bee colonies for pollination services. This practice is well established in many countries and is picking up even in India.

Apiculture fits very well with the concept of Integrated Farming System because of the following reasons.

- IFS system is indeed an ecofriendly low input organic farming which is highly favourable for bee keeping.
- Bee keeping helps in realizing higher crop productivity. It adds upto farm profitability mainly through increased cross pollination. It has been estimated that the value of increase in crop yields through pollination is 15-20 times more than the value of honey produced by honey bees.
- Cross pollinated crops grown in IFS provide either pollen or nectar or both for the bees.
- Crop diversity maintained and crop rotation followed in IFS give ample good for bees.
- Mutualistic relationship existing between bees and bee crops makes apiculture an ideal component in IFS.
- Crop pollination requires a large population of bees during the brief blooming period of each crop and honey bees are one of the few potential pollinators that can be cultured in large number. Colonies can be fed and managed so that peak populations are obtained to coincide with bloom.
- Bee keeping does not take up any extra land and it does not compete with other enterprises for land.
- Scope for bee keeping will be substantial whenever the crop husbandry component involves silviculture along with agriculture and / or horticulture since sustained food availability is ensured for bees almost round the year in such a situation.
- Indeed, loss of native bees as a result of habitat destruction, insecticide impact and lack of diversity in monocultural systems necessitate the inclusion of apiculture as a vital component in IFS.
- Hive products like honey, pollen and propolis obtained through bee keeping fetch additional income for farmers.
- Apiculture also generates new employment opportunities or leads to effective utilization of family labour.
- The farmer can also hire the bee colonies to needy farmers for pollination service. Thus the farmer can also earn money through pollination rental as practiced in western countries.

Major Challenges

Many factors can pose a challenge to beekeepers and hinder the promotion of beekeeping in the Hindu Kush Himalayan region. They can be broadly grouped under

threats to bee survival, barriers to honey trade, lack of knowledge, and non-conducive policies. The main factors are summarized below.

Threats to survival

- Reduction in bee foraging areas as a result of deforestation and forest fires
- Poor accessibility to forage areas (forest and farming) as a result of the limited road network
- Use of poisonous pesticides
- Limited use of biological measures for protection of crops against pests and diseases

Barriers to honey trade

- Lack of a pesticide residue monitoring programme;
- lack of accredited laboratories and equipment;
- lack of a certification
- Poor quality honey due to lack of processing and packaging services at different levels

Lack of knowledge, skills, and awareness

- Lack of awareness at the farmer's level about the role of honeybees in pollination and biodiversity conservation
- Lack of knowledge sharing among key stakeholders both within countries and especially at the regional level
- Lack of skilled labour and effective mobilization of existing labour
- Lack of technology development and research on beekeeping
- Non-conducive policy environment
- Inadequate policies on beekeeping

BEGINNING BEEKEEPING

To be a successful beekeeper one should acquire full knowledge of bee behaviour, hive operations and acquaintance with nectar and pollen plants. Sincere efforts and promptness in meeting the needs of bee colonies is the backbone of the profession. Bees face many hazards of diseases, enemies and poisoning and beekeeper should be alert to safeguard bees against these.

Basic requirement :

- Acquire knowledge of bee behaviour and management from books and bulletins.
- Gain experience by working with a successful beekeeper.
- It is highly recommended to attend short training courses in apiculture.
- It is advisable to start with fewer colonies and multiply and increase number later as you acquire experience.
- Bee colonies can be purchased in hives from beekeepers / organization.

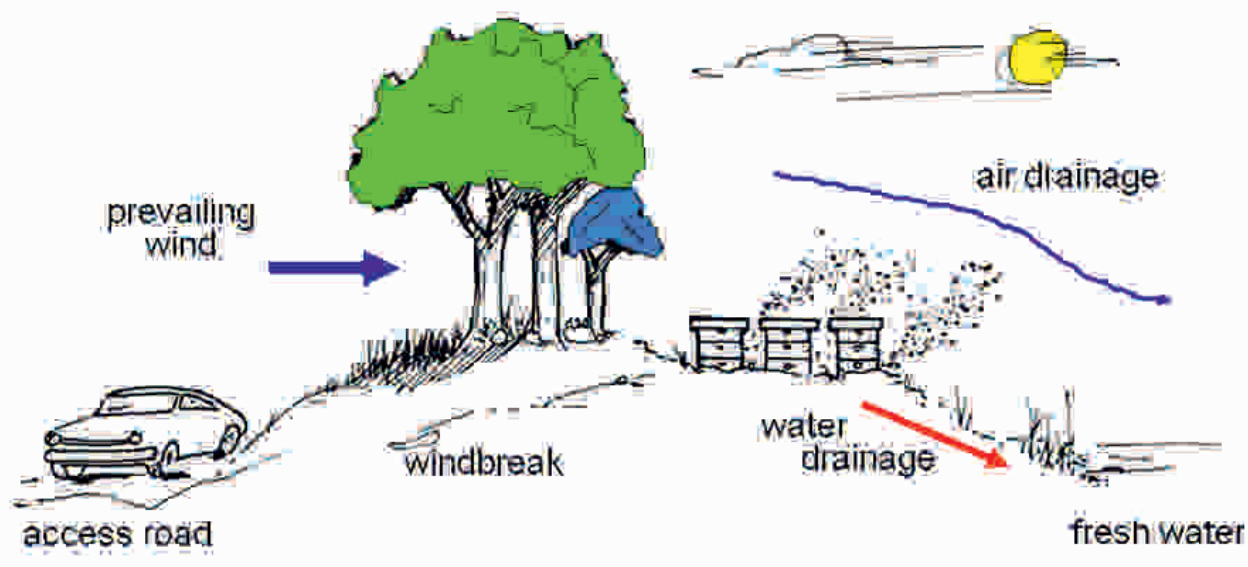
When to Start :

There are regional climatic variations and, therefore, it is difficult to specify the exact time but as a thumb rule, enough blossoms should be available for supply of food requirements for brood rearing. Well established colonies can survive and face the problems but poorly started colonies in bad floral and climatic conditions are difficult to establish. A beginner is not conversant of needs of colonies. Beekeeping can even be started in any season, provided the beginner knows the needs of the colonies at that time and manages accordingly.

Area/ site requirement:

An ideal location should provide enough spring forage for repid build up and later avail major nectar flow for long duration. Nectar producing plants of wide variety and seasonal distribution provide a base for profitable beekeeping. The locality should provide economic surplus of nectar and pollen.

To start beekeeping, the knowledge of local flora is essential. For hobbyist any location can be good but for commercial venture the assessment of the flora should be very exact. Commercial beekeepers generally migrate their bees from one place to another and my produce more than one honey crop of different types. Large number of amenity, highway, forest and social forestry trees are good bee flora. Many crop plants also surve as good bee forage. Irrigated cropped areas present ensured flora.



Climatic Protection

The bee colonies should be located in shade in areas where the temperatures go above 95^{0}F in summer and fall. This shade can be provided by boards laid on top of the hives, by harbors, by shrubbery or under thick shade giving trees. Bees have greater difficulty in lowering down hive temperature during summers. During winter in north India, the colonies are better if these hives are not shaded and located in sun.

Good Air Drainage

Air with high moisture should be regularly drained away from the apiary. Dampness is bad for bee flight and effects the colony's capacity to regulate nest temperature. Air drainage is more important in rainy season in India.

Wind Breaks

Wind breaks of trees or artificial structures give protection against cold winds. This is especially during build up period when colonies are weak and weather is unsettled in cooler areas.

Water :

Artificial source of water should be managed in the apiary if natural sources are not available. Adding some common salt makes water more attractive.

Hive Arrangement & Density :

Spread and stagger the colonies in both directions, space them as wide as possible. Bees get advantage of land marks. Economic foraging distance of Indian honeybee is about one km and that of *A. mellifera* is 2 km, though, they go in search of nectar and pollen and fly farther if necessary but longer foraging distances are not advantageous in terms of energy balances. Assessment of suitable density of hives in a locality is a difficult job. Overstocking of a locality means reduced honey production. Under tick floral conditions the

apiaries can be set apart at about one kilometer. One hive per 2.5 hectare area should be appropriate. A radius of 0.6 km would present a foraging area of about 115 hectare and this area can economically support about 50 bee hives. The number of bee colonies in an apiary would be lower under poorer floral conditions. As a principle each new location should be tested with fewer colonies then regular the number according to seasonal conditions affecting plant growth.

BEE COLONY INSPECTION

Introduction

Bee colonies must be inspected in order to know the status of colony development, whether any diseases are present, whether there is actively performing queen, the amount of brood (eggs, larvae, and pupae), food (pollen and nectar stores), to check whether colony has sufficient space for the queen to lay eggs and to detect if the colony is making any preparations for absconding/swarming and to undertake prevention measures. This information helps in determining and planning seasonal management practices. Colony inspection is performed from outside and inside (by opening the hive).

Appropriate Weather and Time

- The best time to inspect a colony depends on the weather and also the bees' daytime routine.
- Inspection should be carried out during clear and calm weather.
- Inspection should not be carried out when it is hot and bright, cold, cloudy, or

threatening storms or rain.

- Colony inspection is easier when a large number of bees are out foraging and fewer are in the hive
- Colony inspection should be carried out at 2 to 7 day intervals if the colony has shown a swarming impulse or signs of disease or pests, and after introducing a new queen or queen cell.

Table : Appropriate time for colony inspection

Hills and mountains	**Winter**	**11am-2.00pm**	**Every 2-3 weeks**
	Summer	**08-10.00am and 4.00-5.00pm**	**Every 10-15 days**
Foothills and plains	**Winter**	**10.00am-2.00pm**	**Every 3 weeks**
	Summer	**7.00-10.00am and 4.00pm - 6.00pm**	**Every 10 days**

Preparation

The following equipment and accessories should be collected together before the inspection:

- Bee veil
- Hive tool
- Knife
- Smoker or cotton cloth roll
- Gloves if wanted
- Observation form
- Pen

Steps in inspection

- Gently smoke the entrance and wait for few minutes
- Remove the roof and lay it on the ground with the bottom upward just behind the hive
- Check for the presence of spider, cockroach and lizard inside the roof
- Remove the crown board by levering at each corner with the hive tool if propolised.
- Check for the presence of queen on the under surface of the crown board
- Remove the super and keep it diagonally on the upturned roof
- Close the super with the crown board
- Smoke between the brood frames if the bees are defensive
- Push all the brood frames away from you with a hive tool creating a small gap.
- Gently lift the end frame without rolling the bees, using the hive tool as a lever initially.
- Examine the first frame and keep it slanting against the hive stand on the ground
- Remove and inspect the frames one after another
- Methodically turn the brood frame of Indian bees to observe both the sides of the comb
- Keep the brood box over the super after brood nest inspection
- Check for the presence of wax moth larvae or dead bees on floor board
- Clean the floor board thoroughly
- Replace the brood box over the floor board
- Put back the super on the brood box.
- Inspect the super frames in a similar fashion

- Close the hive with the top cover and inner cover

Colony inspection form

Apiary site : Date :

Colony number	Food stores			Bee status					Presence of disease/enemies
	Brood	Honey	Pollen	Egg	Larva	Pupa	Ault	Queen	

Excellent = + + + Medium = + + Poor = + Nil = –

Do's and Don't in hive inspection

Do's

- Inspect the colony in good weather
- Use veil until you gain confidence in handling bees
- Use smoke judiciously to calm the bees
- Ensure the smoker is functioning properly through out the inspection
- Always stand by the side of the hive
- Scratch the bee sting with a finger nail or hive tool
- Replace the frames in the same order in the brood chamber
- Handle the frame properly to avoid comb breakage
- If the bees are aggressive even after smoking close the hive and postpone hive inspection
- Record your observation in a note book to know about the hive history and works to be done to the inspected colony.

Dont's

- Don't open the hive on a windy day or a rainy day or at night
- Don't stand in front of the hive entrance
- Don't kill the bees by crushing while removing and replacing the frames
- Never make any sudden movements when bees are buzzing around you
- Don't use smoke excessively which will alarm the bees
- Don't pull out the sting, if you get stung
- Avoid using scent and strong smelling shampoos and lotions
- Don't inspect the box unnecessarily

Important points

- The inspector should wear unscented, clean, and colourless clothes.
- The inspection should be carried out quickly and gently.
- Continue the inspection even if the bees sting, without becoming over-excited. Stings should be removed gently.
- If the bees are angry and defensive, immediately close the hive by replacing the cover.
- Strong and healthy colonies should be inspected first followed by weak or diseased and angry colonies.
- If the queen is seen in a brood frame while inspecting, take extra care and replace in the brood chamber immediately.
- After inspecting diseased colonies, wash hands and any equipment and accessories thoroughly with soap and water before inspecting another (healthy) colony. Otherwise wash hands and equipment with soap and water at the end of the inspection.

HONEYBEE SPECIES

- Honey bees belong to the family **Apidae,** suborder **Apocrita,** of the order **Hymenoptera.**
- There are about 9 different known species of bees that make honey.
- The most commonly recognized honey bee species, *Apis mellifera* Linnaeus, is native to Africa and Europe, and subdivided into about 24 subspecies.

Species

Apis cerana : The Indian hive bee

The three races occur in India. Their distribution is as follows.

Apis cerana cerana	North-western region including Himachal Pradesh and Jammu and Kashmir
Apis cerana himalaya	North-eastern region including the north-eastern Himalayan states
Apis cerana indica	South India, including Kerala, Tamilnadu, Karnataka and southern Andhra Pradesh

Apis dorsata, The rock bee or giant honeybee

Apis florea, Little bee

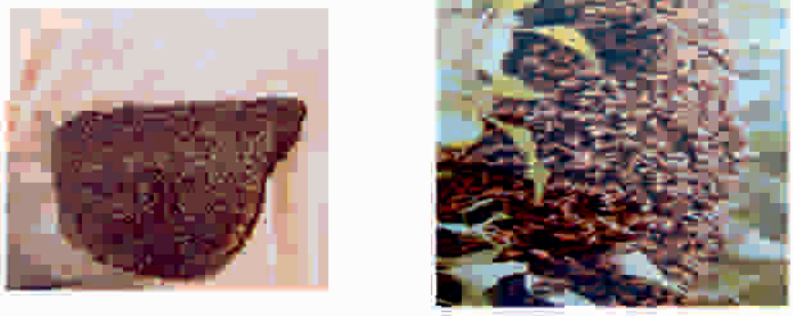
Apis mellifera, The European or Italian bee or western honeybee

Desirable characteristics of colonies kept for economic purposes are :

(i). Capable of adopting to floral resources.
(ii). Reproductive efficiency to maintain strong colonies.
(iii). Calm and easily managed bees.
(iv). No or little swarming and absconding instinct.
(v). Good honey gatherers.
(vi). Less prone to the attack of diseases and capable of overwintering well.

Apis florea and *Apis dorsata* build single comb nests in the open, *florea* in low bushes and *A. dorsata* in trees. Like other tropical honeybees they are prone to migrations, at times over considerable distances. These migrations may be seasonal or in some cases may be a defence against predators and parasites. Although unsuitable for apicultural use, both these species make a major contribution to the supply of honey and wax in the countries in their territorial range. Human predation usually involves destruction of the nest including the brood, but in some areas collection of honey is practised without destruction of the nest, and some honey gatherers even provide nest sites to which they transfer the whole colony. The lifestyle of Apis cerana is similar to that of the Western Honeybees, and like *Apis mellifera* it is used in apiculture with modern moveable comb hives. The numerical strength of A.*cerana* colonies is usually much less, and honey yields are smaller. It is therefore being rapidly supplanted by imported Mellifera races, chiefly A.m.ligustica. Bees of the genus Apis are not the only bees which contribute to the World's supply of honey and wax. Some species of Meliponinae form very large colonies and store sufficient honey to make their exploitation worthwhile. Modern apicultural methods are inapplicable, but tribes of Central and South American Indians have kept such bees in "hives" for hundreds of years. (It should not be inferred however, that Stingless bees are necessarily gentle and easy to handle; they may carry out mass attacks on large intruders such as man, inflicting painful bites with their powerful mandibles. some species inject a caustic venom which causes severe burns to the areas of skin affected.

Nests of *Apis dorsata* on branch of tree



Nest of *Apis cerana*

Apis florea on a branch of plant

Apis florea **:** It builds a single comb nest. There are 3.50 cells per linear cm. drone cells are 1.55 times larger in diameter. They choose shaded places in bushes or trees for nesting. Comb is always covered by more than one layer of bees. Honey yield per colony is about 250gms.

Apis dorsata **:** It is larger in size than all other bee species. It also builds single comb, fixed to a tree branch or under a roof or rock. Breadth of worker cell is about 5.3 mm and drone cells are also of the same size. Bees cover the comb like a curtain. Colony can yield upto 50 kg of honey. The bee colonies migrate long distances to avoid dearth periods and unfavourable weather conditions.

Apis cerana **:** Body size of bees varies from south to north India. The worker comb cell size varies according to size from 4.3 to 5 mm in diameter. Drone cell is 1.2 times wider than worker cell. The species serves the commercial beekeeping in most parts of the country. It is managed in modern bee hives and hives with different bee space are specified by ISI. The species has great draw back in their strong swarming instinct and absconding tendency. Honey yield from a colony varies from 3 to 10 kg and Kashmir race may yield even upto 25 kg per year.

Apis mellifera **:** It is most widely distributed species o honeybee in the world. It is larger in size than other domesticated Indian honeybee. Appearance and drone cell is 1.3 times larger. The bee species was introduced and established in India in 1960's and has been very successful in northern states of Himachal Pradesh, Punjab, Jammu & Kashmir and Haryana. Average honey production is 25-30 kg per year per colony. There are many distinct and very variable races of this species in different parts of the world. The species in being tested in other states through the coordinating centres of All India Coordinated Project on Honeybees.

Characteristics of *Apis* species

Table : Comparative characteristics of *A. mellifera* and *A. cerana*

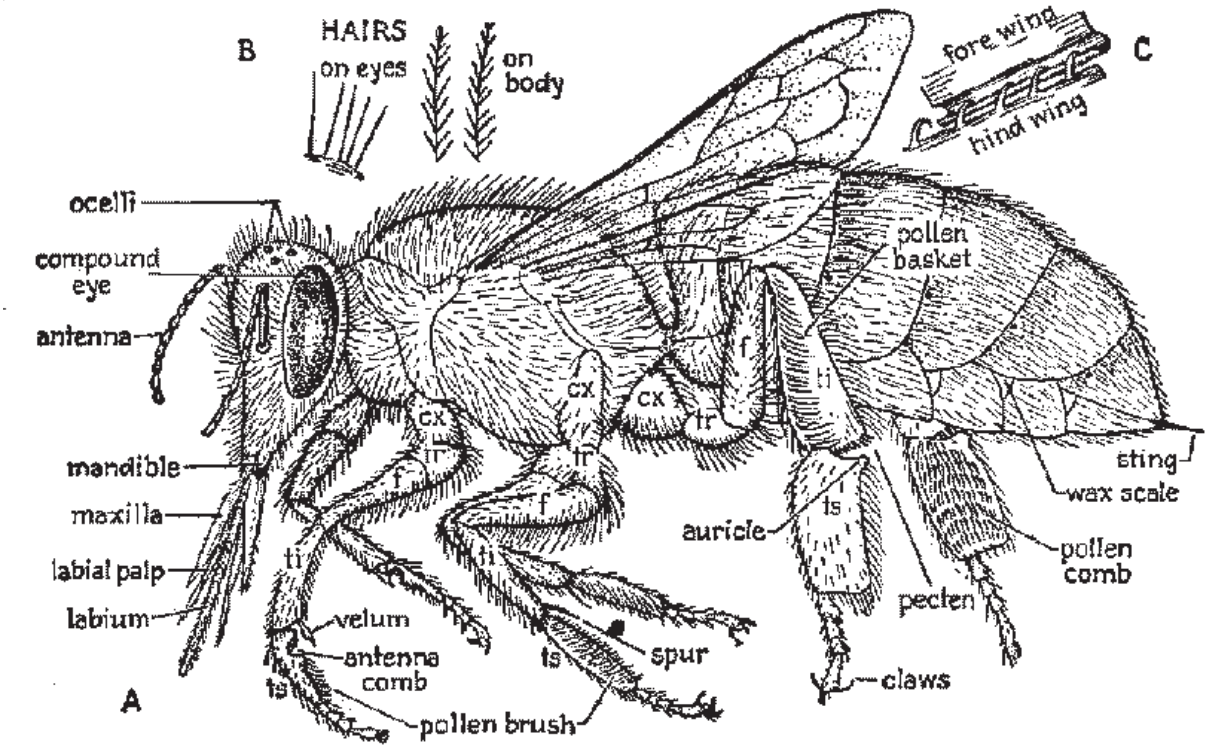
Characteristics	***A. mellifera***	***A. cerana***
Body weight (mg)	90 -120	50 -70
Tongue length (mm)	5.7 -7.2	4.39 -5.53
Nectar load (mg)	40 -80	30- 40
Pollen load (mg)	12 29	7 -14
Flight range (km)	2 -5	0.8 -2
Egg laying capacity of queen per day	800 -1800	300 -800
Colony build up at honey flow	40,000 -60,000	25000 -30,000
Swarming	Little	High tendency
Absconding	Very little	Very high tendency
Aggressiveness	Usually calm	Mostly furious
Robbing tendency	Low	High
Bird/mite infestation	High	Low
Wax moth infestation	Low	High
Defensive behaviour	Poor	Very good
Docility	More docile	Less docile
Drone brood cell	Cell cap with a central pore	No pore in the cell center
Yield under Indian conditions (kg/colony)	25 -30	4 -5

HONEYBEE MORPHOLOGY AND ANATOMY

The Honey Bee Body

Honey bees have many characteristics common to all insects. Insects have a hard outer covering called an exoskeleton, rather than an internal skeleton like vertebrates. The exoskeleton, which is made of a material called chitin, helps to protect the internal organs of the insect and helps prevent desiccation (drying out). In order to grow, the insect must shed the exoskeleton.

Insects have three body regions: the head, thorax and abdomen. The head contains the sensory organs, and appendages for ingestion. The thorax contains the appendages for locomotion, the legs and wings. The abdomen contains the organs for digestion and reproduction.



The honeybee worker. *A*. Mouth parts, pollen-collecting structures, and sting. *B*. The hairs. *C*. The wing-locking mechanism. Leg segments: *cx*, coxa; *tr*, trochanter; *f*, femur; *ti*, tibia; *ts*, tarsus.

Honey Bee Anatomical Characteristics

Abdomen. The honey bee abdomen is composed of nine segments. The wax and some scent glands are located here in the adult. The sting is contained in a pocket at the end of the tapering abdomen in adult females.

Antenna(e). The form of the antenna in insects varies according to its precise function. The antennae are feathery in male moths, elongated in the cockroach, short and bristle-like in the dragonfly, and bead-like in the termite. In honey bees, the segmented antennae are important sensory organs. The antennae can move freely since their bases are set in small socket-like areas on the head. Each of the antennae are connected to the brain by a large double nerve that is necessary to accommodate all of the crucial sensory input. The tiny sensory hairs on each antenna are responsive to stimuli of touch and odor.

Eye(s). Honey bees and people do not see eye to eye. Although honey bees perceive a fairly broad color range, they can only differentiate between six major categories of color, including yellow, blue-green, blue, violet, ultraviolet, and also a color known as "bee's purple," a mixture of yellow and ultraviolet. Bees can not see red. Differentiation is not equally good throughout the range and is best in the blue-green, violet, and bee's purple colors.

Like most insects, honey bees have compound eyes that are made up of thousands of tiny lenses called facets. Scientists think that each facet in a compound eye takes in one small part of the insect's vision. The brain then takes the image from each tiny lens and creates one large mosaic-like picture. This image is somewhat analogous to the image produced on a television screen, in which the "picture" is essentially a grid composed of dots of light. The advantage of the compound eye is its ability to detect movement. Honey bees can easily differentiate between solid and broken patterns, but show a preference for broken figures.

Related to this, bees respond more readily to moving flowers than to stationary ones. Therefore, their eye is better adapted for movement perception than for form percep tion.

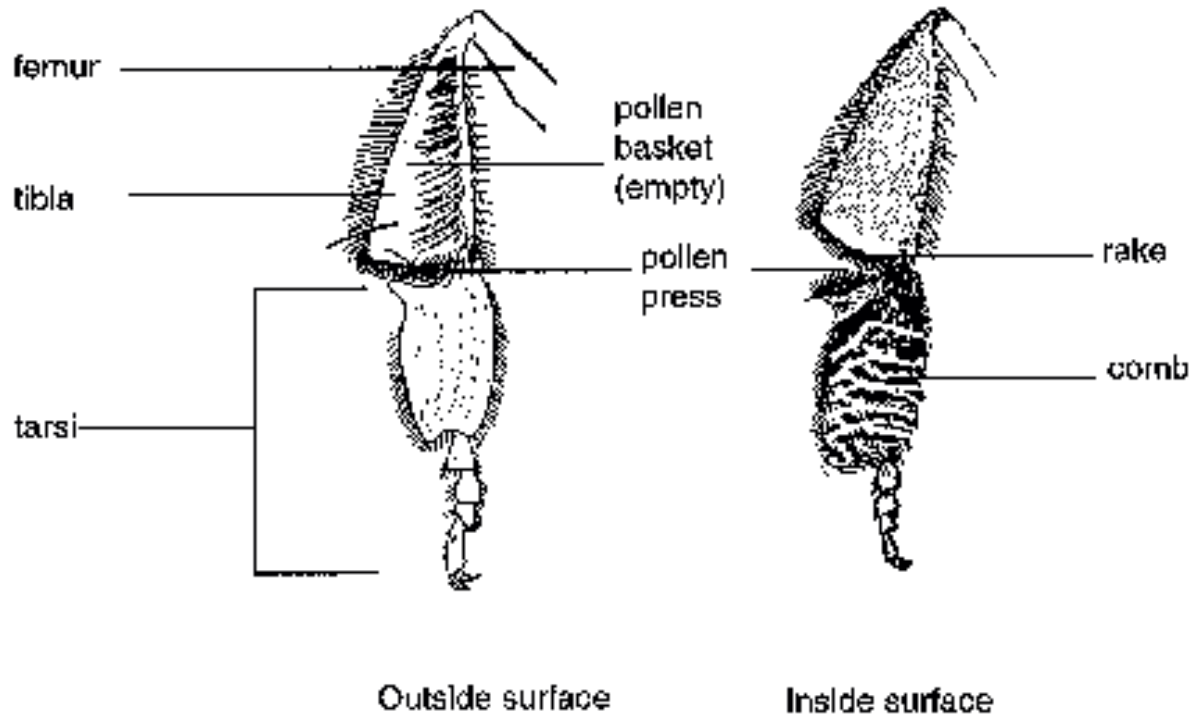
Honey bees also have three smaller eyes in addition to the compound eyes. These simple eyes or "ocelli" are located above the compound eyes and are sensitive to light, but can't resolve images.

Head. The honey bee head is triangular when seen from the front. The two antennae arise close together near the center of the face. The bee has two compound eyes and three simple eyes, also located on the head. The honey bee uses its proboscis, or long hairy tongue, to feed on liquids and its mandibles to eat pollen and work wax in comb building.

Mandible(s). The honey bees have a pair of mandibles located on either the side of the head that act like a pair of pliers. The mandibles are used for any chores about the hive that require grasping or cutting, such as working wax to construct the comb, biting into flower parts (anthers) to release pollen, carrying detritus out of the hive, or gripping enemies during nest defense.

Proboscis. The proboscis of the honey bee is simply a long, slender, hairy tongue that acts as a straw to bring the liquid food (nectar, honey and water) to the mouth. When in use, the tongue moves rapidly back and forth while the flexible tip performs a lapping mo tion. After feeding, the proboscis is drawn up and folded behind the head. Bees can eat fine particles like pollen, which is used as a source of protein, but cannot handle big particles.

Leg(s). The honey bee has three pairs of segmented legs. The legs of the bee are primarily used for walking. However, honey bee legs have specialized areas such as the antennae cleaners on the forelegs, and the pollen baskets on the hind legs.



Pollen Basket(s)

A smooth, somewhat concave surface of the outer hind leg that is fringed with long, curved hairs that hold the pollen in place. This enclosed space is used to transport pollen and propolis to the hive.

Pollen Press

Once the bees have gathered the pollen, they move it to the pollen press located between the two largest segments of the hind leg. It is used to press the pollen into pellets.

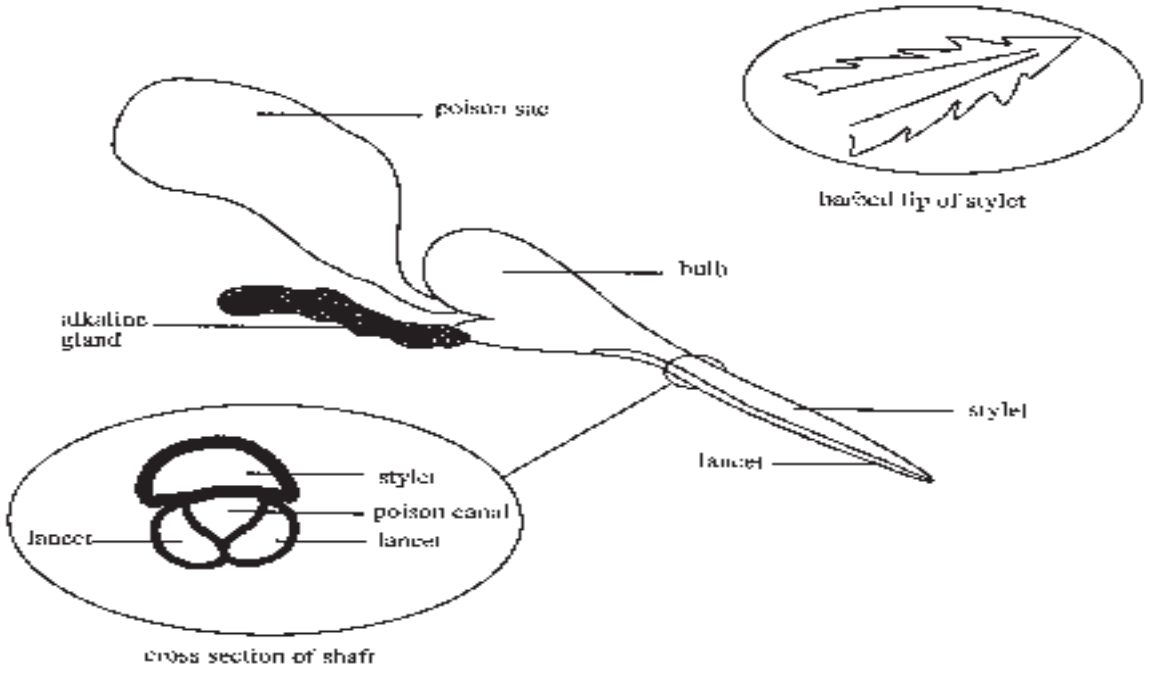
Rakes and Combs

Structures on the legs used to collect and remove pollen that sticks to the hairy bodies of honey bees.

Sting

The stinger is similar in structure and mechanism to an egg-laying organ, known as the ovipositor, possessed by other insects. In other words, the sting is a modified ovipositor that ejects venom instead of eggs. Thus, only female bees can have a stinger. The sting is found in a chamber at the end of the abdomen, from which only the sharp -pointed shaft protrudes. It is about 1/8-inch long. When the stinger is not in use, it is retracted within the sting chamber of the abdomen. The shaft is turned up so that is base is concealed. The shaft is a hollow tube, like a hypodermic needle. The tip is barbed so that it sticks in the skin of the victim. The hollow needle actually has three sections. The top section is called the stylet and has ridges. The bottom two pieces are called lancets. When the stinger penetrates the skin, the two lancets move back and forth on the ridges of the stylet so that the whole apparatus is driven deeper into the skin. The poison canal is en closed within the lancets. In front of the shaft is the bulb. The ends of the lancets within the bulb are enlarged and as they move they force the venom into the poison canal, like miniature plungers. The venom comes from two acid glands that secrete into the poison sac. During stinging, the contents of the alkaline gland are dumped directly into the poison canal where they mix with the acidic portion.

When a honey bee stings a mammal, the stinger becomes embedded. In its struggle to free itself, a portion of the stinger is left behind. This damages the honey bee enough to kill her. The stinger continues to contract by reflex action, continuously pumping venom into the wound for several seconds.



Thorax

The thorax is the middle part of the bee and is the anchor point for six legs (three pair), as well as two sets of membranous wings in the adult. Pollen baskets for carrying pollen back to the hive are located on the hind legs.

Wax Gland(s)

Four pairs of glands that are specialized parts of the body wall, which during the wax forming period in the life of a worker, become greatly thickened and take on a glandular structure. The wax is discharged as a liquid and hardens to small flakes or scales and sits in wax pockets. The worker bee draws the wax scales out with the comb on the inside hind leg. The wax scale is then transferred to the mandibles where it is chewed into a compact, pliant mass. The beeswax is then added to the comb. After the worker bee outgrows the wax forming period, the glands degenerate and become a flat layer of cells.

Wing(s)

The honey bee has two sets of flat, thin, membranous wings, strengthened by various veins. The fore wings are much larger than the hind wings, but the two wings of each side work together in flight. Just flapping the wings does not result in flight. The driving force results from a propeller-like twist given to each wing during the upstroke and the downstroke.

COLONY ORGANISATION

Honeybee comb

A comb a collection of hexagonal cells made up of bees wax. These cells are horizontally parallel to the ground, their closed ends are back to back and open ends are towards the opposite direction, forming the two surfaces of the comb. Functionally, there are three types of cells.

1. The attachment cells with which the comb is attached to the top of a wooden frame.
2. The storage cells for storing honey and pollen.
3. Brood cells, for rearing the young ones. The brood cells are subdivided into:

a) **The worker cells** The cells in which worker bees are reared. There are 17.6 such cells in 4 linear inches

b) **The drone cells** The cells in which drone bees are reared. There are 22 such cells in 4 linear inches in the *Apis cerana* and comb and 19.3 cells in *Apis mellifera* comb.

c) **The queen cells** The cells in which queens are reared. These are much bigger and look like ground nut shells

A comb has three more or less distinct horizontal zones:

- The honey zone forms the top most portion.
- The pollen zone comes below the honey zone. These cells store the pollen.
- The brood zone is the lowermost portion. In this zone eggs and brood are reared.

Honey bee castes

Every honey bee colony comprises of a single queen, a few hundred drones and several thousand worker castes of honey bees. Queen is a fertile, functional female, worker is a sterile female and the drone is a male insect. During active season the colony has few thousands of workers, a queen and few hundreds o drones.

Worker Bees :

Worker bee is a underdeveloped female. There may be 20,000 to 80,000 in a hive. They do all the work of building the combs, collecting and storing nectar and pollen, feeding the larvae and cleaning the hive. These bees perform all the duties in the hive and field except reproduction. They have division of labour and their life is spent working, engaged in cleaning of cells guarding the entrance, building combs and feeding the brood. After 20 days they venture out to field and gather nectar and pollen. A bee's life span is about 6 weeks during active brood rearing season but lives longer when foraging and brood rearing activity is low. The workers build three types of wax cell, differing in size or shape. The queen lays eggs in each of the cells and the eggs hatch into larvae. The workers feed the larvae until they are ready to pupate and then they put a wax capping over the cell. After 10-11 days the capping is bitten off and the adult bee emerges. The eggs laid in the drone cells are unfertilized and develop into males. The eggs laid in the worker cells and queen cells are fertilized but the queen larvae are fed a different diet from that of the larvae in the worker cells. The difference in diet causes the workers to be sterile and the queen to be fertile.

In nutshell the duties of worker bees are : .

Duties of a worker

1. Their adult life span of around 6 weeks can be divided into
a) First three weeks- house hold duty.

b) Rest of the life- out door duty.

House hold duty includes

a. Build comb with wax secretion from wax glands.

b. Feed the young larvae with royal jelly secreted from hypopharyngeal gland.

c. Feed older larvae with bee-bread (pollen+ honey)

d. Feeding and attending queen.

e. Feeding drones.

f. Cleaning, ventilating and cooling the hive.

g. Guarding the hive.

h. Evaporating nectar and storing honey.

Outdoor duties

1. Collecting nectar, pollen, propolis and water.
2. Ripening honey in honey stomach.

Duties of the house bee

The duties of a house bee are -

1. cleaning the hive and the comb
2. feeding the brood
3. caring for the queen
4. making orientation flights
5. comb building
6. ventilating the hive

7. packing pollen, water, nectar or honey into the combs
8. executions
9. guard duty

The Queen :

Her only job is to lay eggs. Egg laying capacity is low in *Apis cerana* as compared to *A. mellifera*. queen is fed on glandular food by the worker bees and number of eggs laid per day depends upon the quality and quantity o this food. There may be no egg laying during winter in hills and very little in summer in plains. Young queen takes mating flights and mates with upto one dozen drones. The spermatozoa are stored in her spermatheca for her life time. Queen may have to be replaced every year in very good beekeeping areas but normally It is good for two years.

In nutshell the duties of a queen bee are

Duties of a queen

1. The only individual which lays eggs in a colony .(Mother of all bees).
2. Lays upto 2000/day in *Apis mellifera*.
3. Five to Ten days after emergence, she mates with drones in one or more nuptial flights.
4. When her spermatheea is filled with sperms, she will start laying eggs and will not mate any more.
5. She lives for 3 years.
6. The secretion from mandibular gland of the queen is called queen's substance.
7. The queen substance if present in sufficient quantity performs following functions.

a) Prevent swarming and absconding of colonies.
b) Prevent development of ovary in workers.
c) Colony cohesion is maintained.

8. The queen can lay either fertilized or sterile eggs depending on the requirement.

The Drone :

Drones do not perform any hive duty. Their sole function is to mate with queen and are driven out of the colony when no more needed in the colony. The life of a drone is approximately 6-8 weeks.

Developmental stages of the three castes of bees.

Development duration of stage			
Stage	**Queen**	**Worker**	**Drone**
Days	3	3	3
Egg	5-1/2	6	6-1/2
Larval stage			
Pupal stage	7-1/2	12	14-1/2
Total developmental time	16	21	24

Table : Some structural differences between worker, queen and drone

Characteristic	Worker	Queen	Drone
Sensory			
No. facets of compound eyes	4000-6900	3000-4000	7000-8600
Optic lobes of brain	Medium	Small	Large
No. antennal plate organs	3000	1600	30,000
Relative ratio of antennal surface	2	1	3
Glandular			
Hypopharyngeal	Present	Vestigial	Absent
Mandibular	Large	Very large	Small
Head salivary(labial)	Large	Large	Vestigial
Thoracic salivary(labial)	Large	Large	Small
Wax	Present	Absent	Absent
Nasonov	Present	Absent	Absent
Alkaline(dufour)	Reduced	Large	Absent
Koshevnikov	Reduced or absent	Present	Absent
Reproductive and sting			
Ovaries and testes	Reduced ovaries	Enlarged ovaries	Testes
No. ovarioles	2-12	150-180	None
Spermatheca	Rudimentary	Large	None
Sting barbs	Strong	Minute	No sting
Mouth parts			
Mandibles	Slender	Robust	Small
Mandibular groove	Present	Absent	Absent
Proboscis	Long	Short	Short
Leg and wing			
Pollen press and combs	Present	Absent	Absent
Pollen basket	Present	Absent	Absent
Wing sensilla	Medium	Fewest	most
Number	20,000-60,000 workers present per colony	Only one queen present per colony under normal conditions	Few hundred drones present during the period when they are required for mating

Sex	Imperfect females, reproductive structures not well developed with reduced ovaries.	It is perfect female	Perfect males
Size	Medium in size	Biggest in size	Bigger in size
Wings expanse	Wings cover the entire abdomen	Wings donot cover the entire abdomen	Wings cover the entire abdomen
Sting	They have sting called spines	Sting slightly curved and longer	Sting absent
Thorax	Thorax short	Thorax broad	Thorax broad
Abdomen	Abdomen pointed V-shaped	Abdomen pointed V-shaped	Abdomen blunt
Pollen basket	Pollen baskets present	Pollen baskets absent	Pollen baskets absent
Wax glands	Wax glands present	Wax glands absent	Wax glands absent
Food supply	Not dependent	Dependent upon workers	Dependent upon workers for food
Development period	21 days	16 days	24 days

BEE BEHAVIOUR

Honeybees are highly developed social insects. The importance of honeybees makes the man interested in its perpetuation. The behaviour in these social insects is guided by instinct. It is essential to acquire knowledge about their behaviour to make it possible for man to control and efficiently manage this valuable insect.

Division of Labour :

Worker bees of different ages perform different duties. During the first three days after emergence the worker bees remain busy in brood area where the nest temperature is regulated to about 93^0F. These bees are concerned with cleaning of cells. They start feeding honey and pollen to older larvae when they are about 4 days old. The food glands of worker bee develop and secrete "royal jelly" and she tends the younger larvae when 6-12 days old. There is again shift in duties at the age of 14 days when bees wax glands become active. She secretes wax for comb building and do any other duty in the hive. The worker bees become field foragers at about the age of 21 days after emergence. This division of labour is not a rule and there can be a change in the schedule, depending upon the needs in the hive.

Worker bees start taking orientation flight during second week of their emergence. These play flights are meant to acquaint themselves with vicinity of the hive and scope of the play flights increases with age.

Communication and Memory :

Field bees search the pollen and nectar sources and bring a load to hive. Distance and direction of the source is communication to fellow foragers by means of peculiar dances which are performed in relation to the position of the sun. The riches of the source is communicated by the liveliness of the dance. Other bees then go in the direction and search for the source with scent perceived from the pollen or nectar load of the dancer. They have the capability to calculate the position of the sun without seeing it.

Field bees memorize the location of the source at the particular time of the day, depending upon the pollen or nectar presentation by the flowers. The bees continue to visit the source till some better source is found out.

Communication in bees

Sir Karl Von Frisch (1967) : Professor of Zoology at the University of Munich in Germany Book **"The Dance Language and Orientation of Bees"** Cambridge Press, USA. He was awarded the Nobel Prize in Physiology or Medicine in 1973 for his discoveries. Honeybees perform 2 type of dances on their return to the hive, known as round dance and waggle dance.

Round **dance** : When a food source is very close to the hive (less than 50 meters), a forager performs a round dance

The waggle dance or wag-tail dance : Performed by bees foraging at food sources that are more than 100 meters from the hive. This dance communicates both distance and direction. A bee that performs a waggle dance runs straight ahead for a short distance, returns in a semicircle to the starting point, runs again through the straight course, then makes a semicircle in the opposite direction to complete a full figure-eight circuit. While running the straight-line course of the dance, the bee's body, especially the abdomen, wags vigorously from side to side. This vibration of the body produces a tail-wagging motion. At the same time, the bee emits a buzzing sound, produced by wing beats at a low audio frequency of 250 to 300 hertz or cycles per second.

Control of Reproduction :

In the honeybee colony worker bees have undeveloped reproductive system and queen is the single developed female. Queen's mandibular gland secretion is dispersed over whole of her body. The workers lick this queen or diminish under overcrowded conditions during swarming. Under these circumstances there is initiation of queen cell building by workers and the development of ovaries of the workers. The laying workers may appear in the colony if the colony does not succeed in replacing the queen. The eggs laid by such workers produce drones.

Field Activities :

Foraging activity provides raw materials for the hive. The materials collected are nectar, pollen, water and propolis.

Nectar : Nectar is a sweet-surgery secretion of the nectaries of flowers and other parts of the plant. The nectar is sucked up and stored in honey stomach. After reaching the hive the forager unloads herself by distributing the load to hive bees. Hive bees ripen the nectar. During the process there is enzymatic conversion of sugers and moisture is reduced. These hive bees than seek out cells and deposit the drop of unripe honey. Nectar load is 15-30 mgs in Indian bees (varies with race) and 30-40 mgs in mellifera. Each day 10-20 loads may be brought in by a forager visiting 50-500 flower for each load.

Pollen : Pollen is important for brood earing, since it is a protein source. A load of

pollen varies from about 20 kgs and each load is collected from 50 to 200 flowers. A load is collected in 10-20 minutes and as many as 45 loads can be collected each day by a forager.

Water : Water is required in the hive for dilution of honey for larval food when there is no nectar income. Water is also needed to requlate nest humidity and for cooling down hive temperature through evaporation by fanning the bees. Water foragers complete a trip in about 5 minutes and have average of 50 trips per day.

Propolis : It is a sticky resinous material. Propolis is used to stick down frames, for proofing the walls of hive and cover unwanted debris which cannot be pulled out by bees. Indian honeybee does not collect propolis but mellifera bees are heavy propolisers.

Temperature Control :

Bees cannot regulate their body temperature individually but can regulate colony temperature. When atmospheric temperature drops below 57^0F bees form a cluster and the compactness of the cluster increases with the decrease in temperature. The heat produced by the muscular movements by bees is conserved by the cluster.

Brood Cycle :

Bees cluster below 57^0F and remain inactive in cooler regions where the winter temperatures are low and no flora is available. Brood rearing is stopped, but in most parts of India the winters are milder and flora from oilseed crops is available. In such areas the bees do forage but the working hours restricted to 4-5 hours. Brood rearing is there and colonies grow in strength.

Brood rearing starts or increases two weeks before spring flowers appear. Pollen and nectar are eagerly gathered. Large quantities of water are also collected for elaboration of food. New bees emerge and they can now cover larger comb areas, thus the brood rearing is rapidly expanded. The brood nest becomes crowded in late spring and the colony prepares for swarming. New queens are reared and the old queen leaves with "prime swarm". Secondary swarms may be issued later on. Swarming instinct is more prominent in Indian hive bee as compared to mellifera.

Nectar which remains unused is stored as surplus during early summer in the form of honey. Pollen is stored as bee breed.

Because of high summer temperatures and lack of flora, the brood rearing is stopped. Colony strength depletes. The drones are deprived of food and driven out to die.

During later part of monsoon season some subsistence flora becomes available to bees and some brood rearing is resumed which picks up with flowering of *Brassica* Crops.

BEEKEEPING EQUIPMENTS

Bees are managed in modern hives. The hive design is based on the principle of "bee space". There is space between the frames, between top bars of frames and inner cover and between the frames and inner walls and this space allows the free movement of bees. Because of the bee space the parts are not attached to each other. Hive is composed of bottom board, brood chamber, brood chamber frames, super chamber and super frames, inner cover and top cover. There are different types of hives, with different bee spaces, being used for different species and races of bees.

BEE HIVES

Bee hives were designed after the discovery of "Bee Space" (or) "Bee Passage" by L. L. Langstroth. It is the optimum distance to be left in between two adjacent comb surfaces in a

bee hive which is essential for normal movement and functioning of bees. It is too small for comb construction and is too large for propolis deposition. It varies with honey bee species.

e.g. Indian bees - 7 - 9 mm: Italian bees - 10 mm

Advantages of bee keeping in movable frames

- Hive volume can be increased (or) decreased based on need
- Bees can be fed artificially
- Artificial queen rearing can be done
- They allow easy inspection and manipulation of colonies.
- They allow very efficient honey harvesting because the honeycombs, within their frames, can be emptied of honey and then returned to the hive.

Types

The British standard hive, Jeolikote villager hive, I.S.I hive: "A Type" **I.S.I hive**: "B Type" Newton's hives, BIS hives and Marthandam hives are suited for rearing Indian bees. Langstroth hives are suited for rearing Italian bees.

A. Langstroth ten- frame hive

1) Stand: four legged stand 15-25 cm high to support the bottom board properly.

2) Bottom board: it can be made either by taking a piece of wood 550mm long ,450 mm broad and 22 mm thick, or by joining 2 wooden boards together nailing in position with wooden rods. Along each end of the longer side is nailed a wooden rod 550 mm long ,22 mm broad and 22 mm thick and another wooden rod 363 mm x 22mm is nailed at the back. The front is provided with entrance rod which is 363 mm x 22 mm x 22 mm and this has an entrance 75 mm long and 22 mm deep in its middle.

3) Brood chamber: It is a rectangular box without top and bottom and is made of 22 mm thick wood. Its length on the outside is 406 mm and on the inside 363 mm and its height is 238 mm. A rabbet 16 mm deep and 13 mm wide is cut along the entire of its width planks.

4) Frame: consist of top bar, two side bars and a bottom bar dimensions for self spacing frame are given below

   (i) Top bar: 475 mm long, 25 mm wide and 22 mm thick. It is cut to 9 mm thickness on both sides for a length of 25 mm. it has a groove , in the middle of its lower side for fixing the comb foundation sheet.

   (ii) Side bar: each is made up of 9 mm thick wood and is 226 mm long .the upper part of each is 34 mm wide and lower part 25 mm wide. Each is cut from the middle portion at either end to accommodate the top and the bottom bars, respectively. There are 4 holes in each side bar for wiring the frame.

   (iii) Bottom bar: 440 mm long, 19 mm wide and 9 mm thick. The outside measurements of the frame are 440 mm x 228 mm.Two 15 mm staples should be driven in (to leave only 9 mm outside) to top bar on its opposite side, so that the frames stand 34 mm apart. Tinned wire of 28 gauge should be used in wiring the frame.

5) Super: The dimensions of the super and the super frames should be same as those of the brood chamber and brood chamber frames, respectively.

6) Inner cover: This is a wooden board to cover the brood chamber or the super as the

case may be. It is 500 mm long, 406 mm broad and 9 mm length wood. It has 9 mm thick and 22 mm wide wooden bar nailed on to each of its four sides.

7) Top cover: It is made up of 9 mm thick wooden board nailed to a rectangular frame 50 mm high ,all covered over with a metallic sheet so as to make it impervious to rain water. Its inside measurements are 525mm x 425 mm .It rests loosely over the hive.

Dimensions of Movable Frames :

Name	Brood Frame	Super Frame
British Standard	350 x 212 mm	350 x 212 mm
Langstorth	440 x 228 mm	440 x 228 mm or 440 x 230” mm
Dadant	462 x 281 mm	462 x 156 mm
ISI (Bee space 7 or 8 or 9mm) A type B type	 230 x 165 mm 300 x 195 mm	 230 x 85 mm 300 x 105” mm
Newton	206 x 144 mm	206 x 62 mm
Travancore	300 x 150 mm	300 x 100 mm

1. Hive stand: This is used to keep the bee hive above the ground (15-25 cm high) so as to protect the colony from termites, ants and other crawling insects, as also prevent soil moisture getting into the hive or facilitate ventilation from below the hive.

B. Comb foundation mill: This is a machine to prepare comb foundation sheet used in beekeeping to make bees build regular combs in frames, that are convenient to handle.

C. Comb foundation sheet: It is a thin sheet of bee wax embossed with a pattern of hexagons of size equal to the base of the natural brood cells on both sides. For *A. mellifera* there are 19 cells and for *A.cerana* 22- 23 cells/100 mm linear length.

D. Embedder: A spur embedder or an electric embedder and transformer is used to embed wires into the comb foundation sheets.

E. Dummy Division Board/ Movable wall: A wooden board of the size of a frame placed inside the brood chamber, used to reduce the size of the bee nest in a hive. Dummy board is used to reduce the free space in the hive that helps the bees in containing heat within the nest and also useful to protect them from enemies.

F. Feeders: Used for providing sugar syrup as feed to the bees during dearth period.

G. Queen Cage: It is a cage made up of wood or wire gauge or plastic structure used for

queen introduction of transport of queen either with a few attendant worker bees, in packages.

H. Queen gate: Piece of queen excluder sheet with holes large enough to allow free movement of worker bees, but too small to allow queen's passage. Queen gate is used to arrest the queen bee in the hive, during seasons of food scarcity or during inclement weather, when there is a danger of bees deserting the hive.

I. Queen excluder: A flat metal screen with parallel slots of 4.0 to 4.2 mm width is placed above the brood chamber to prevent queen going into the honey storage area above, and laying eggs in the honey combs.

J. Queen cell protector: It is a cone shaped structure made of a piece of wire wound spirally used to protect the queen cell, given from a queen right to queen less colony until its acceptance by bees.

K. Bee escape board or super clearer: This is a wooden or metal device which allows the bees to go through a self closing exit.

L. Pollen trap: This is a device attached to the bee hive to remove pollen loads from the returning pollen foragers and to collect them in a tray.

M. Drone trap: This device is used at the entrance to reduce the drone population inside the hive.

N. Swarm trap: It is a rectangular box used to trap and carry the swarm. It is fixed near the hive entrance with one or two combs inside during the swarming season.

O. Hive tool: This is a flat metal rod of varying design and size used commonly while handling bees in the hive.

P. Smoker: A beekeeper uses a smoker to produce cool smoke to calm the bees while handling them.

Q. Protective clothing:

a. Bee veil: It is worn over the face for protection against stings.

b. Gloves: These are used while inspecting and handling colonies to protect hands and arms.

c. Overalls: Light coloured cotton materials are preferable since they are cooler and create less risk for antagonizing bees.

d. Boots: A pair of gum boots will protect the ankles and prevent bees from climbing up under trousers.

Q. Swarm net: This is used to hold a swarm of bees and transport it to the apiary.

R. Bee brush: A soft camel-hair brush is used to remove bees off the honey comb before it is taken out for extraction of honey.

S. Decapping knife: Single or double edged steel knife is used for removing wax cappings from the honey comb before putting it in the honey extractor.

T. Frame gripper: A helpful tool for holding frames when inspecting the colony.

U. Honey Extractor: This is a metal drum or barrel with a gear mechanism to rotate a honey frame holder kept in it. Honey combs are kept in the extractor after removing the caps on the cells. After removal of honey, the combs can be re-used in the hive since the cells and the comb remain intact.

SEASONAL COLONY MANAGEMENT

Management is the key in the success of beekeeping. All good beekeeping conditions can be nullified if the management of on apiary is faulty and ill planned. It is useful to start with few bee colonies and build up the stock. Bees need to be protected in extreme weather conditions, during dearth periods, and from diseases and enemies. Success of a beekeeper depends upon his knowledge of bee behaviour and his aptitude to enjoy working with bees. Following outlines give the broad guidelines, though modifications and deviations are must depending upon the local conditions.

Annual Cycle of a Colony

The annual cycle or pattern of a honeybee colony reflects the process of sustaining the colony around the year based on the climatic conditions and weather, and the availability of forage. The annual cycle is affected by seasonal change. The morphology, anatomy, and genetic character of honeybees is adapted to allow continued development and maintenance of a colony even under unfavourable climatic conductions.

Seasonal Colony Management

Seasonal colony management is the set of management practices designed to meet the different needs of a colony over the year. Colony management is an integral part of modern beekeeping and is essential to maximize honey production, for colony division, for the production of other bee products, and for providing pollination services. The honey flow period is the time when the most flowering plants are available for forage. The off season or dearth period is the time when little forage is available and the climatic conditions are unfavourable for foraging. The timing of these periods differs in different locations. The approximate timings at different altitudes of the Himalayan region are provided as a guide in Table :

Table : Honey flow and dearth periods at different altitudes in the Himalayas

Area	Honey flow season	Off season (dearth)*
High hills	April, May, June, July, August	September, October, November, December, January, February, March
Mid hills	April, May, September, October, November, February, March	June, July, August, December, January
Foothills and plains areas	April, October, November, December, January, February, March	May, June, July, August, September

* The honey flow and off (dearth) seasons vary according to forage source and exact location

Activities before and during the honey flow season

Before the season

- Establish a healthy colony prior to the honey flow season.

Seasonal Management :

Honey flow season :

Beekeeping calendar starts with the activity of bee colonies in spring after prolonged winter

cold. Colonies expand by increased brood production. In very cold regions the brood rearing starts about a fortnight before first flowers appears. But in plains of India the winter brood rearing is enhanced in spring.

- Clean hives.
- Observe the presence and performance of the queen.
- Check the status of the brood and adult bees.
- Widen the entrance of strong colonies.
- Provide a honey super once all the brood frames are full and the colony active to create a good working environment for the bees. Fill all ten slots with frames with previously harvested combs that have been cleaned, or with comb foundation if no used combs are available.
- Add additional frames to the super as needed.
- Wait until 70% of honey cells in the super are capped and then harvest honey.
- Check the combs in the brood chamber and remove any that have been abandoned or that look very old (blackened).
- Control and manage swarming.
- Avoid using drugs to treat a colony during the honey flow season. If disease and pest attacks occur, apply suitable control measures but don't harvest the honey.
- Feed colonies and keep them warm if there is a cold wave during the honey flow season, especially during winter in foothill and plains areas.
- Keep bee colonies in the shade if it is dry and hot.
- Equalize the strength of bee colonies by transferring of brood frames (after shaking off bees) or by exchanging the positions of week with strong colonies
- Stimulant feeding during early spring boosts the morales of bee colonies and brood rearing is sufficiently increased.
- Keep on adding stored combs as the strength increase.
- Be careful about robbing; any negligence will induce it.

Off-Season (Dearth) Management

The dearth period is very risky for both bees and beekeepers. Colonies may become weak due to scarcity of food, pest and disease attacks, and robbing and absconding. The following management practices should be adopted in the off season (dearth) period.

Winter off season

- Maintain strong and disease free colonies
- Colonies headed by young and virgin queens
- Ensure the bee colonies have enough food through feeding management.
- Keep bee colonies warm by narrowing the entrance and ventilator.
- Remove empty combs and use a dummy board(s). Unite weak and queenless colonies.
- Don't harvest honey during a cold period.
- Place the colonies in a sunny location with the entrance facing south to east.
- Migrate colonies to warmer areas if possible.
- Avoid colony division and queen rearing
- Protect colonies by giving winter packing.

Dry and summer off season

Bees have to survive the intense summer heat and rains when it is a dearth period, therefore:

- Ensure the hives have sufficient food and water.

- Keep the bee colony strong by feeding them sugar, and if necessary by uniting weak colonies.
- Take appropriate measures to control pests and disease.
- Take appropriate measures to prevent and control absconding.
- Unite weak and queenless colonies.
- Take appropriate measures to prevent colonies from robbing.
- Keep the bee colonies under a roof or shade during the rainy season. Make temporary open structures with reed or grass roof.
- Remove empty combs and store in a safe place.
- Avoid colony division and queen rearing.
- Widen the ventilation and entrance to enable better air circulation
- Relative humidity during summer is also very high water twice during day time. Feed dilute sugar syrup in case insufficient stores.
- Make arrangement for water Supply.
- Keep bee colonies where air does not stagnate, during rainy season.
- Feeding pollen supplements and helps the colonies to continue brood rearing.
- Feed concentrated sugar syrup (60-70%).

SWARMING

Swarming is the natural process used for colony reproduction. In swarming, the old queen flies away from the hive with thousands of worker bees to form a new colony (Figure 46). In the first swarming, the mother queen leaves with 50–70% of the workers. There may be further swarming with a virgin queen. Repeated swarming reduces the number of workers each time, which may leave the colony and late swarms too weak to survive.

Symptoms of Swarming

- The number of drone cells and drones in the colony increases
- Queen cells are seen at the edges of combs
- Bees cluster at the hive entrance
- Bees hover around the hive making a piping sound

- There are many bees flying a short distance from the existing hive and clustering on a nearby tree branch or similar place.

Causes

- Genetic trait
- Congestion in the colony
- Lack of space for egg laying
- Lack of space for hive food storage
- Increase in temperature
- Delay in requeening

Season and Time

Swarming takes place when there is a sufficient flow of pollen and nectar. The most favourable time is spring and autumn at lower altitudes, and, May, June, and July in the high hills. Swarming usually takes place on a sunny day from around 9 to 10 in the morning to 3.00pm in the afternoon. In hot areas swarming may start earlier at around from 7 or 8 am. Swarming does not occur when it is rainy or stormy.

Prevention

- Inspect the colony at regular intervals.
- Allow sufficient space in the brood and super for brood rearing and honey storage.
- Add new comb foundation so that the bees can make more comb cells for eggs and collection of nectar and pollen.
- Destroy unnecessary queen cells.
- Remove any combs with unnecessary drone cells.
- Enable good ventilation with full air circulation in the hive.
- Requeen the colony with a quality queen each year.
- Place a queen gate at the hive entrance if there are signals indicating the start of swarming.
- Divide the colony.

Swarm capture

If a colony does swarm, it should be captured and rehoused as follows (Figure).

- Try to settle the flying bees by spraying dust and water.
- Allow the bees to cluster for a while at one place.
- Capture the swarm with the help of a swarm bag or basket
- Hang the bag with the swarm near the desired area for the new hive
- Put the swarm in a new beehive
- Transfer combs with nectar, pollen, and brood from the existing hive to the new hive.
- Provide supplementary feeding if there is a food deficit.
- Use a queen gate for 3 days to keep the queen in the new hive

a) capturing a swarm with a swarm bag

b) capturing a swarm with a basket

Hanging the swarm bag with the captured swarm hiving the swarm into a new hive

e) new hive with queen gate fitted

Swarm hanging on a branch.

Small hive placed under swarm.

Cover is placed on hive and bees are allowed to collect inside

Bees shaken off branch and into hive.

ABSCONDING

Introduction

Absconding is the process in which a honeybee colony completely abandons a hive as a result of problems. Absconding can result from unfavourable conditions, especially during the dry season or dearth period and in hot and rainy weather. Absconding usually takes place during the day between 10 am and 3 pm. Two types of absconding can occur: planned and emergency.

Symptoms of Absconding

- Workers create a non-laying environment for the queen 15 days before absconding.
- The number of eggs, larvae, and pupae in the colony is reduced.
- Stores of nectar and pollen are depleted.
- Fewer bee flights (incoming and outgoing) are seen at the entrance.
- Many workers fly around the hive making piping sounds. Bees take off fast and fly higher.
- After planned absconding, combs are left empty. Some brood and honey may be left after emergency absconding.

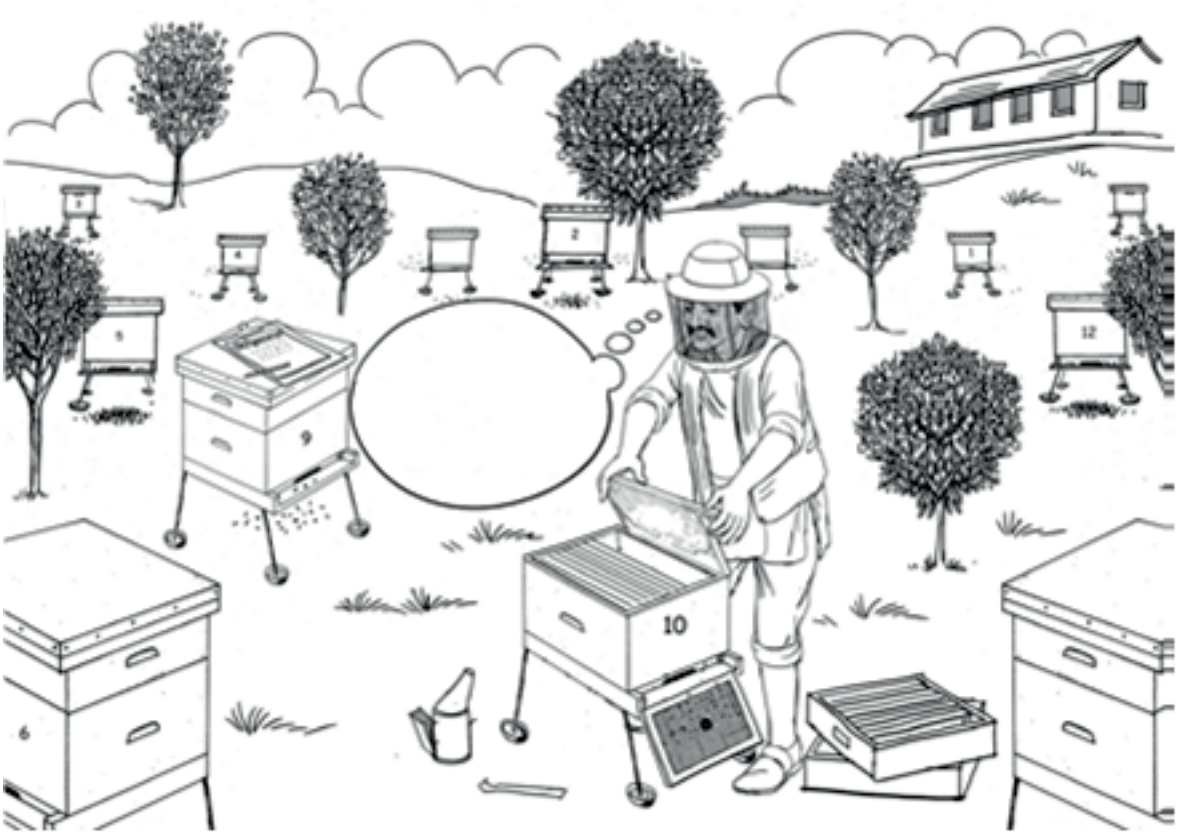


Figure: An empty hive with no brood, bees, or food – the bees have absconded

Causes

- Lack of food during the dearth period due to harvesting all the honey at the end of the honey flow season
- Endemic disease and attack by pests

- Too high a dose of medicine given to a diseased colony
- Inadequate and inappropriate seasonal management of the colony
- Transfer of a colony from a traditional to an improved hive at an unfavourable time of year
- Poor transfer of a colony from a traditional to an improved hive as a result of having inadequate technical skills
- Use of a sub-standard improved hive and technology
- Disturbance to bees as a result of poor methods of colony inspection
- In the case of *Apis cerana*, robbing as a result of insufficient space between hives
- Lack of an appropriate and safe site and obstacles in the path of bees flying to and from the entrance
- Genetic trait

Differentiating Absconding from Swarming

Swarming and absconding are similar in the followig ways.

- Worker bees crop the honey and exit from the hive at a specific time.
- The worker bees fly away after the queen bee exits.

Table : Differences between swarming and absconding

Swarming	Absconding
Swarming occurs during the honey and pollen flow season because of population growth and lack of space (congestion) in the hive.	Absconding occurs during the dearth period and/ or because of adverse conditions resulting in weakening of the colony, including climate, lack of food, and occurrence of pests and disease.
Bees continue foraging.	Bees stop foraging.
Only a portion of the colony leaves the hive.	All bees abscond.
Brood, pollen, and honey stores remain in the comb after swarming.	Combs are generally empty after absconding, although some workers, brood and honey may be left.
The swarmed bees settle temporarily nearby at a lower height while deciding on their destination.	The destination has been decided, so absconded bees fly at greater height and settle permanently away from the apiary.
Bees fly at a lower height.	The bees fly higher and fast.
The swarm settles easily into a new hive and starts foraging immediately after hiving.	An absconded colony that is captured and placed in a hive does not settle easily and tries to abscond again.
A new colony develops after swarming. This is a colony multiplication procedure and can be beneficial for a beekeeper	Absconding is migration and no new colony develops. It is harmful for beekeepers.

Control and Management of Absconding

- Leave some honey when harvesting at the end of the honey flow period.
- Feed with sugar syrup continuously for 3 days if the brood combs don't have any food stores.
- Ensure timely investigation and treatment of diseases.
- Protect colonies from pests.
- Do not disturb the colonies with over frequent colony inspection.
- Undertake seasonal management practices to protect bee colonies from cold, hot, and moist conditions.
- Place additional brood combs from a strong colony into a weak colony and protect the colony against robbing.
- Place beehives at an appropriate site that protects them from heat, cold, and other disturbances such as smoke, vehicle noise, and animal transit.
- Requeen the colony every year.
- Provide additional brood combs from a strong colony to a colony suspected of planning to abscond during hive inspection.
- Make the bee entrance small using a queen gate.
- Try to settle the colony nearby through dusting or sprinkling water.
- Hive an absconded colony into a new hive after capture and placing the hive in a separate place to try and prevent further absconding.
- Have a skilled technician transfer a colony from a traditional to an improved hive during a favourable season and using appropriate technology.
- A colony in an apiary showing signs of absconding should be transferred to another hive and placed separately in a different place, otherwise other colonies may also develop an absconding impulse.

COLONY DIVISION

Introduction

Colony division is a method of multiplying bee colonies, i.e., producing two or more colonies from a mother colony. Colony division is used to control swarming, as well as in commercial beekeeping to increase the number of colonies. The colonies can be used to increase the number of colonies in the apiary for honey production or sold for income. Colony division during the honey flow season can reduce honey production

and it is necessary to decide whether division or honey production should have priority.

Points to Consider

Time/Season

Usually the best time for colony division is during the honey flow season. According to geographical location, colony division can be performed twice a year. For example, in foothill and plains areas, first between mid February and mid April and again between early October and early November. Commercial beekeepers can carry out artificial queen rearing and use the queens for colony division as needed.

Weather

- Colony division should not be performed in rainy or cold periods.
- The best days are reasonably sunny and warm.
- Colony status

- The mother colony selected for division should be strong and healthy. A strong colony means 10 frames covered with bees of which 6 contain brood, and sufficient stored food (honey and pollen).
- The colony should have drones and queen cells.

Colony characteristics

Only the best colonies should be selected for multiplying. Selection should be based on the following

characteristics:

- Egg laying capacity of the queen
- Honey and pollen collection capacity of the colony
- Good defensive behaviour and resistance to pests and disease
- Low tendency to swarm or abscond
- Capacity for rapid recovery of the population during the onset of honey flow, and able to maintain the population during the off season

Planning for Colony Division

Before dividing a colony, the mother colony should be selected, a decision taken on the time and season of division, and all the required materials collected together and prepared.

Equipment and Materials

- Empty hive including a dummy board
- A strong mother colony
- A frame fitted with comb foundation and empty comb
- Feeder/sugar
- Colony inspection equipment

Methods for Colony Division

Natural division using queen cells developed during swarming

The presence of multiple queen cells in a colony during the swarming season indicates a need for division. Dividing such colonies and using the queen cells in new daughter colonies can help control swarming. However, although it solves the immediate problem of swarming it does not help improve the genetic traits.

Colony division from queen production

Select the best colony based on the selection criteria given above. Produce queens from this colony before the onset of honey flow. These queens can be used to replace the old queen and to start new daughter colonies. The mother colony can be multiplied into several nucleus colonies but each should have at least 2 brood combs and 3–4 combs with food (nectar and pollen). The prepared colonies can then be sold or migrated according to need.

The steps are as follows:

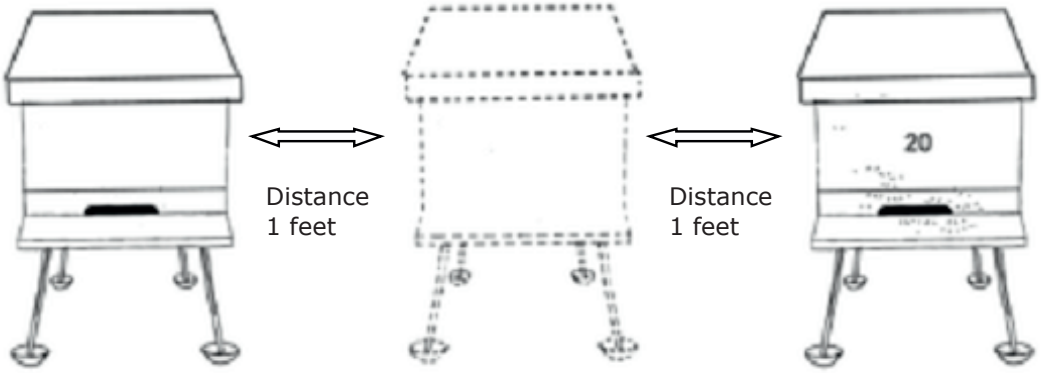
- Select the most appropriate mother colony.
- Move the hive about 1 foot (30 cm) to the left of the existing location.
- Place an empty hive about 1 foot (30 cm) to the right of the previous location, leaving the old location empty.
- Take 3 to 4 brood combs from the mother colony together with the existing queen and place in the empty hive.
- Keep 1 mature queen cell with 3 to 4 brood combs in the mother colony.
- Divide the combs with food stores equally between the hives. Remove any remaining

queen cells.

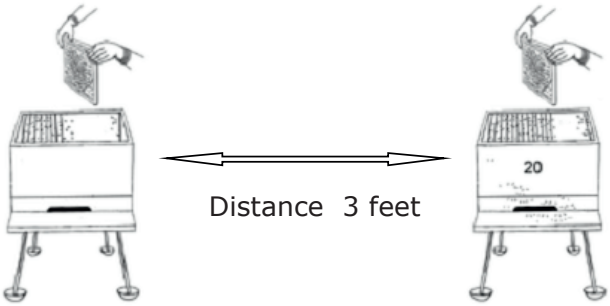
- Divide the adult bees equally between the hives.
- Check whether the incoming foragers are entering both hives equally.
- If more foragers are entering one of the hives, move it further from the previous location and move the other hive closer to the previous location. Continue to adjust until equal numbers of foragers are entering both hives. Add frames with empty combs or comb foundation to the colony with the queen after colony division.
- Close and cover the hives.
- Divided colonies can be moved to the desired position by increasing the distance from the old position at a rate of 1 to 1.5 feet (30 to 45 cm) per day in the evening after the bees have stopped foraging.
- Divided colonies should be fed with sugar syrup in the evening for 3 days after division and comb foundation added as necessary.

Step 1: Inspect the colonies

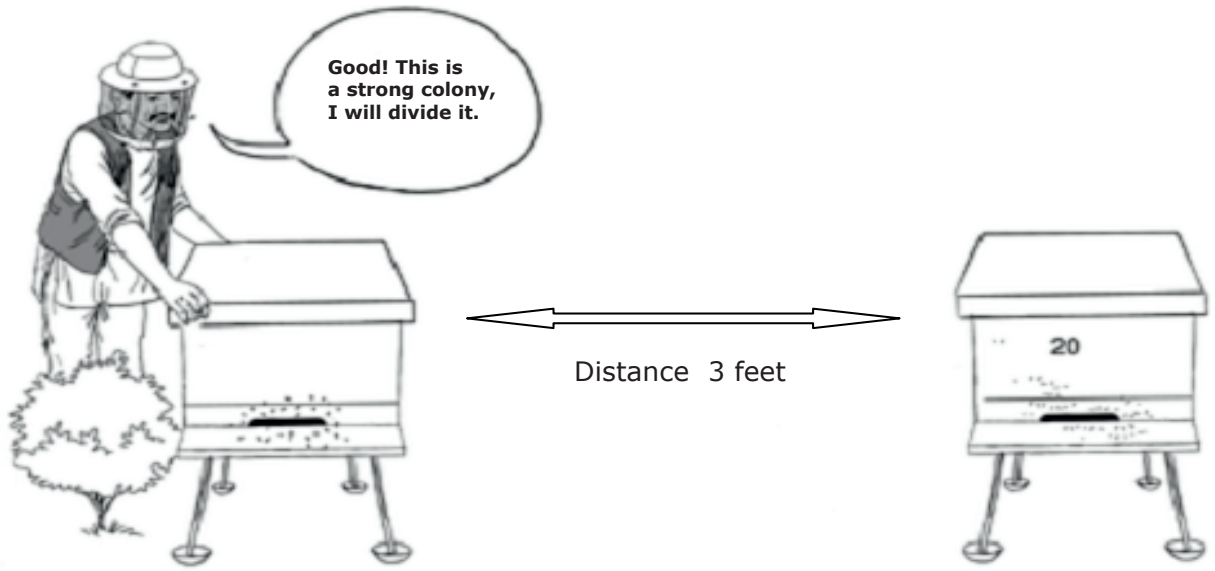
Step 2: Select the best mother colony



Step 3: Move the mother colony 1 ft (30 cm) to the left and place an empty hive 1 ft (30 cm) to the right of the previous mother colony position. The hives are a hive width plus 2 feet apart



Step 4: Put 4 to 5 brood frames with the queen in the new hive



Step 5: Check the colony division is balanced and close the hives with the covers

UNITING BEE COLONIES

Introduction

Weak colonies are of no or little value. They may not overwinter successfully or such colonies in spring may not reach the desired strength. Therefore, such weak colonies should be united. Colonies are united to make a strong healthy colony from two (or more) weak colonies, or one weak and one strong colony, according to the needs of the beekeeper. Uniting the pheromones of two weak colonies results in the development over time of a new and single pheromone for the united, strong, and healthy colony.

The reasons for uniting colonies include the following:

- Weaker colonies: uniting weak colonies results in a single strong colony.
- Queenless colony or weak queen: If the colony doesn't have a queen, and no possibility of producing a new queen (no fertilized eggs or queen cells in the colony), the queenless colony should be united with a colony with a good queen (a 'queen-right colony').
- Worker laying: Sometimes worker bees may lay eggs if the time without fertilized eggs or a queen is too long. The laying workers should be removed as soon as they start egg laying and the remainder of the bees united with a queen-right colony.
- Inability of the queen to lay fertilized eggs: Occasionally a queen may not lay, or may lay only unfertilized eggs which become drones. This can happen under unfavourable weather conditions or when the colony has an emergency queen. Under such circumstances, the non-performing queen can be removed and the colony united with a queen-right colony.
- Increasing honey production: Two or more colonies can be united at the onset of the honey flow season to increase colony strength and maximize honey production.

Points to Consider

- All the foragers should have returned to the hive before colonies are united, thus it is best to unite them in the evening.
- One of the colonies selected for uniting should be made queenless before uniting it with a queen-right colony.

- Be careful not to lose bees from the queenless weaker colony while placing the hive on the paper barrier on top of the brood chamber of the strong queen containing colony.
- Remove any laying workers from the queenless or weak colony.
- The paper placed between the two colonies should be perforated but able to prevent bees from passing through.
- A diseased colony should not be united with a healthy colony unless fully treated and recovered.

Uniting Colonies

Preparation

- Identify the colonies to be united.
- Bring distantly placed colonies closer before uniting. A weak colony can be brought close to the stronger, queen-right colony by moving at a rate of about 2 feet (60 cm) per day.
- Feed the colonies continuously with sugar syrup for 3 days before uniting if food stores are insufficient.
- Remove the queen of the weaker colony 24 to 48 hours prior to uniting.
- Remove all the empty combs and super/s from the colonies to be united during daytime.
- If laying workers need to be removed, the colony should be taken about 200 m away from its existing location and all the bees shaken off the comb before the hive is replaced in its original location. Only the bees that return to the original location should be united
- Remove combs with worker eggs from worker laying colonies before uniting.

Method

The paper barrier method is the safest way of uniting colonies. A perforated paper is placed between the two hives (colonies) to be united. This allows mixing of the pheromones of the two colonies, resulting in a single united colony. Always unite the weak colony with the strong colony, not the strong with the weak.

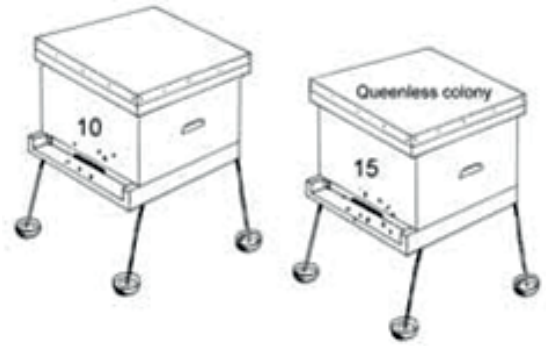
The steps are as follows:

- The colonies to be united should already have been moved close to each other
- Give a light puff of smoke at the entrances of the colonies.
- Remove the (outer and inner covers) of the queen-right (strong) colony and place a perforated paper over the frames to fully cover the brood chamber.
- Spread honey or 2:1 sugar syrup lightly on the paper
- Remove the bottom board of the queenless colony and place the hive on the perforated paper on top of the brood chamber of the queen-right colony. (The smoke will have encouraged the bees to withdraw to the combs so that there are no bees left on the bottom board.)

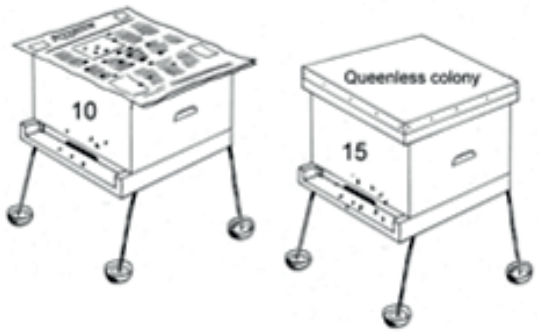
Management

Honeybees from the colonies are united when the pheromones of the two colonies are thoroughly mixed by diffusion through the perforated paper. The bees will chew the paper from both sides; it will disintegrate within 48 hours and the bees will mix. The hive should then be opened and the bees and frames from the upper chamber transferred to the lower chamber so that all the bees are in one chamber. The united colony should be fed with artificial food for 3 days after removing the paper. If required, a super can be added after some days once the brood chamber is full and the united colony fully active, particularly during the honey flow season

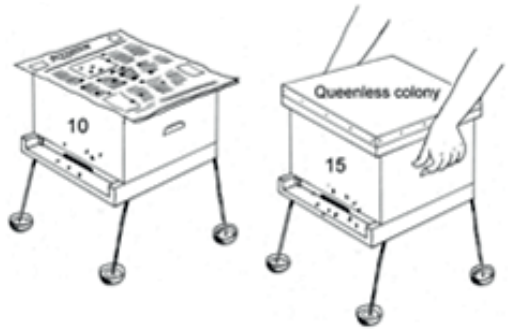
The paper method for uniting colonies



Step 1: Queen-right and queenless colonies moved close together



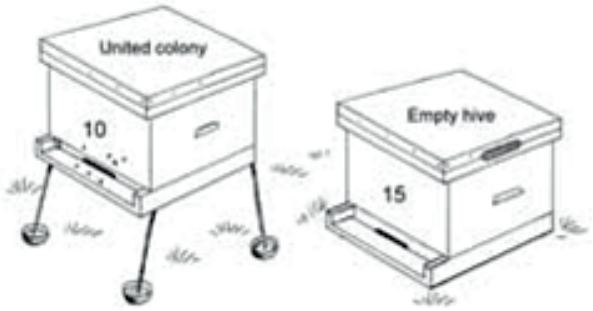
Step 2: Covers of queen-right colony removed and replaced with a sheet of perforated paper smeared with syrup or honey



Step 3: Queenless colony lifted from bottom board

Step 4: Queenless colony placed on sheet of paper

Step 5: Pheromones of colonies allowed to unite while

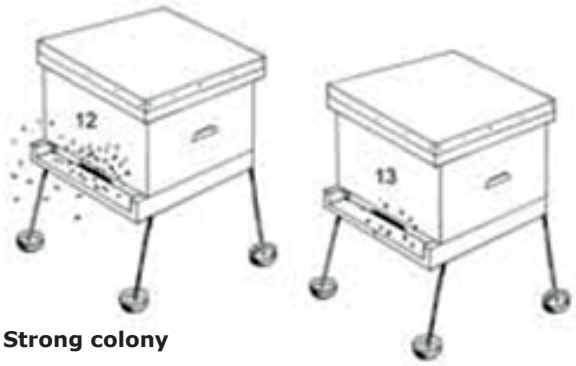


Step 6: After 2 days bees and frames from upper chamber transferred to lower chamber and overs replaced on the united colony

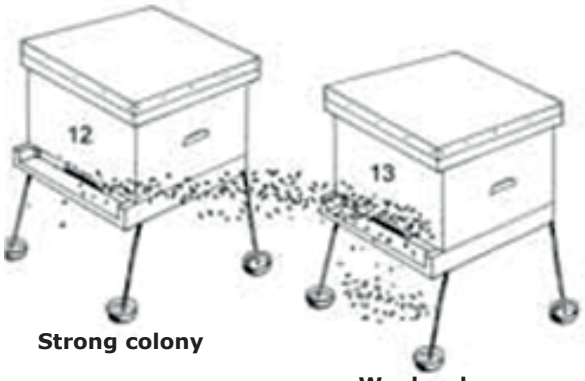
ROBBING MANAGEMENT

Introduction

Bees have strong tendency to search and collect sweet substances to their hives. This tendency often leads them to steel honey from weak colonies and especially when there is a dearth of flora. Robbing is a sign of bee colonies fighting in an apiary. It can have different causes but is usually the result of lack of food in a hive during the dearth period resulting in a stronger colony robbing a weaker one. The robbers enter through holes, cracks, and crevices other than the main hive entrance. The colonies being robbed can be finished. It is difficult to control robbing, therefore it is wise to take precautions.



Strong colony **Weak colony**



Strong colony **Weak colony**

Causes

- Lack of food stores in a hive resulting from complete honey extraction at the end of the honey flow season
- Bees attracted by honey spilled during honey harvesting in an open yard, which stimulates the robbing tendency
- Feeding sugar during the day or spilling sugar syrup
- Syrup left in a feeder during the day
- Differences in colony strength in an apiary
- Inadequate food stores in a strong colony and sufficient honey in a weak colony
- Honey smell emanating during the dearth period as a result of taking too long for hive inspection
- Cracks and crevices in a hive and emanating honey smell
- Feeding syrup only to a few weak colonies
- Wider ventilation leading to emanation of a smell of honey during the dearth period
- Keeping two or more different honeybee species together in an apiary

Symptoms

- Robber bees trying to enter a colony with many workers flying around the hive
- Increased number of guard bees at the hive entrance and fighting between robber and guard bees
- Dead bees seen on the ground near the entrance while flying bees make a strong piping

sound

- Robber bees entering hive with an empty stomach and leave with a swollen stomach Characteristics
- At the start, guard bees can control the robbers at the hive entrance, but then the robber bees start freely robbing honey.
- Robbing continues until the honey store in the colony being robbed is exhausted. Many bees die in the robbed colony, which can push them towards absconding.

Usually robbing is between strong and weak colonies, but sometimes two robber colonies fight each other which kills a large number of bees in both and can lead to absconding or colony destruction. Robbing may also be a species-specific genetic behaviour. *Apis cerana* bees have a tendency towards robbing at any time during both the honey flow and dearth periods, whereas in *Apis mellifera*, robbing is only common in the dearth season.

Prevention

- Examine bee colonies quickly, during dearth period
- Be extra careful when honey is extracted after the honey flow has ceased; robbing is quickly induced
- Minimize entrance space : Minimize all chances of robbers gaining entry into the hive. Entrance can be reduced so that guard bees can defend effectively
- Do not keep combs exposed. This is most important for wet combs after extraction.
- Put green grass on the hive and at the entrance
- Badly robbed colony should be moved to a new place and an empty hive placed at it place.
- Just after robbing starts, water or kerosene mixed with water should be sprayed over the bees, which will encourage the robbers to return to their colony as if it were raining. As an alternative, *Artemisia* or *Parthenium* leaves can be kept in front of the entrance of the colony being robbed to prevent robbing.
- The robber bees cannot enter into a colony if longer weeds or tree branches are kept in front of the entrance.
- Smoke the hive being robbed every 5–10 minutes while robbing is ongoing to calm the bees.
- Narrow the entrance of the hive being robbed so that only one bee at a time can pass through.
- If robbing continues, dust flour over the flying bees and observe where incoming bees are coated with flour or colour to identify the robber colony/ies.
- If robber bees are attempting robbing over a longer period, take the robber colony 1–2 km away from the apiary for at least a week.
- If only one colony is susceptible to robbing, then move the colony being robbed to another site or inside, and place an empty hive with combs that have some honey in them at its original position. The robber bees will finish the honey and then learn that the hive has nothing more to offer and there is no one to fight with and will not return.

Management

- Ensure that all colonies in the apiary are strong.
- Make sure each colony has an emergency honey stock by leaving some honey at the end of the honey flow period; stop harvesting when 20–25% of the honey remains.
- Harvest the honey in a closed yard or use a net if harvesting has to be carried out in an open yard.
- Do not drop honey or syrup around the colonies; if any is spilled, clean it up immediately with a wet cloth.
- Only feed syrup in the evening; remove any remaining syrup early the next day and keep it in a closed room.
- Keep harvested comb in a closed space. Freshly harvested comb can be reused or stored in a box. Older combs can be used to extract wax.
- *Apis mellifera* and *Apis cerana* colonies should be kept in different apiaries to minimize robbing between them.
- Seal any cracks and crevices in the hives.
- Narrow the entrances if robbing starts. Regularly inspect colonies to determine their status.
- Supplement the food for a weak colony with honey from a strong colony as necessary.
- Colonies susceptible to robbing can be placed in a location with long grass in front of the entrance.

MANAGEMENT OF LAYING WORKERS

Introduction

In the absence of a queen, queen cell, or young worker larvae (less than 3 days old), and when any fertilized eggs fail to produce a new queen, some workers feed on the royal jelly themselves and start laying eggs. These are called laying workers (LWs). In *Apis cerana*, workers start laying eggs 7 days after the start of a queenless situation without a queen cell, egg, or young larvae; in *Apis mellifera*, workers start laying eggs after 10 days.

Eggs from laying workers

Causes

- Accidental death of the queen
- Failure of a new queen to lay eggs upon her return to the hive after mating
- Installation of a queen gate for a long period at the hive entrance of a colony with a virgin queen, or clipping the wings of a virgin queen in a colony or swarm
- Colony division with an emergency queen at an unfavourable time

Identification

- Shiny, bulging, black abdomen of worker bees
- Workers seen with their abdomens in a laying position in the cells
- Workers furious, walking with K-shaped wings
- More than 1 egg per cell
- Eggs not centrally positioned in the cell and attached towards the wall
- Smaller eggs than laid by a queen
- Drone brood in worker cells
- Smaller than normal drones emerging from worker cells
- Excess number of drones
- Smaller queen cells built on the faces of the comb, and bees clustering at the entrance to the hive

Control

- Pay attention to the safety of the queen during colony management, hive inspection, and honey harvesting.
- Graft a queen cell or perform requeening immediately in a queenless colony.
- In the absence of a queen cell, place a brood comb with eggs and larvae into the hive.
- Check the status of the queen by colony inspection every 4–5 days after queen cell grafting or the emergence of a virgin queen

Management

- If a colony starts worker laying, remove the laying workers before introducing a queen cell or queen.
- Move the worker laying colony 20 m (65 feet) away and place an empty hive at the previous position.
- Shake off all the bees from the combs in the laying colony onto the ground over a sheet of cloth or newspaper. Shake off the workers' eggs from all the combs after shaking the bees onto the ground
- Place good combs with the eggs removed into the empty hive at the old position.
- Add brood frames from other hives with eggs, larvae, pupae, and honey stores to the empty hive.
- The bees on the sheet that are not able to return to the new hive are laying workers and should be left to die. The normal workers will fly back to the cleaned hive.
- The new hive should be requeened, or the colony united with a queen-right colony.

FEEDING MANAGEMENT OF HONEYBEES

Under favourable conditions colonies should not require artificial feeding but feeding is needed when :

1. Too much honey is removed by beekeeper and little stores are left.
2. Stimulant feeding for increasing brood production in the beginning of spring.
3. To ensure enough stores for overwintering of colonies.
4. For hiving swarms, when hived on combs with little or no stores.
5. For chemotherapy treatment for the control of diseases.
6. For cell builder colonies in queen rearing.

(a). Combs of honey taken from colonies with extra honey can be given to needy colonies but this involves a risk of transmitting diseases.

(b). Normally sugar (30-50% as stimulant feed and 60-70% when there is a shortage of stores) is fed to bees. The feed is given inside the hive in containers (with straw or float to avoid drowning) or filled in combs. To avoid robbing the feed is given to all colonies in an apiary. No syrup should be spitted in the apiary.

Pollen sources are not available to bees all through the year. During dearth period colonies require pollen substitute or pollen supplement so that brood rearing is continued. Artificial food is needed to supplementing the colony's diet during times of food deficiency.

- Artificial feeding is needed to meet the daily energy requirements of a colony if the hive food store is exhausted.
- An artificial diet also activates bees to work.

Different types of artificial food can be used for feeding in different seasons and circumstances. An artificial diet is mainly provided in emergencies. When fed continuously, it should be fed for 3 days followed by a 3-day non-feeding interval. It is important to avoid spillage outside the hive as spilled food can attract pests such as ants that may destroy the colony. The three common types of food are sugar syrup, candy, and pollen substitute.

Sugar syrup

Syrup is used in different concentrations. The amount and strength of syrup is selected according to the specific situation and season.

- 1:1 syrup (1 part sugar, 1 part water) This is normally given as a supplement when there is a food deficiency in a normal colony or during the dearth season in order to activate the colony to work.
- 2:1 syrup (2 parts sugar, 1 part water) This syrup is used to feed medicine and in the cold season.
- 1:2 syrup (1 part sugar, 2 parts water) This syrup is used for feeding in the hot dry season.

Feeding using a frame feeder

- Pour the syrup into a frame feeder, put 5–7 pieces of straw into the feeder extending to the upper edges to prevent the bees from sinking, and place the feeder in the hive
- The feeder can also be loosely covered with clean muslin before placing in the hive to

facilitate feeding.

Feeding using a plastic jar

- Perforate the lid of a plastic jar with a series of holes.
- Pour the syrup into the jar, tightly close the perforated lid, and invert the jar on the lid of the inner cover or on top of the frame bar so that bees can feed from it

Precautions for feeding

- Always feed in the evening, except in special situations such as feeding a new swarm.
- Place the syrup inside the hive not outside.
- Remove the feeder with any remaining syrup in the morning.
- Do not spill the syrup when preparing it or feeding the colony.
- Wipe up any spilled syrup immediately with a wet cloth.
- Do not provide more syrup than needed.
- Feed the syrup on the same day it is prepared.

Candy

Candy is a semi-solid material prepared with finely ground sugar mixed with honey or water. It is used as a supplement during the dearth period. In general, candy prepared from 0.5–1 kg of sugar is enough to feed a colony for 1 day during the dearth. Honey or water can be mixed with the powdered sugar to produce candy, but candy prepared with honey will keep better and is more nutritious.

Preparation

- Grind the sugar to a fine powder on a clean slate or in a mill.
- Mix 200–300 g honey thoroughly with 1 kg powdered sugar. The amount of honey should be just sufficient to give a semi-solid 'candy' consistency. Water can be used instead of honey, but is not as good. Wrap candy in a plastic sheet with closely positioned holes punched in it, or a solid plastic sheet or wax paper with both ends open.

Feeding

Place the candy on the top bars, in an open space in the brood chamber, or in a frame feeder placed in the middle of the brood chamber.

Pollen substitute

Pollen is a basic food for the overall development of honeybees. It is rich in protein which is needed for the physiological development of adults and brood. Ideally bees should be fed in the hive with stored pollen; if this isn't available, an artificial pollen substitute can be prepared.

Artificial diet for dearth period

General	Sugar syrup (250 g)
PAU Diet	Brewer's yeast (42 g) + Gram (4g) + Skimmed Milk Power (4g) + Sugar (50g) + Pollen (10 g)
HAU Diet	Soybean flour (60 g) + Honey (35 g) + Yeast (5g) + Vitamins (1 g/kg)
GBPUA&T diet	Soybean flour (25 g) + Yeast (10 g) + Pollen (15 g) + Skimmed milk powder (5 g) + Honey (22.5 g) + Sugar (22.5 g)

Preparation

- Make flour from soya or gram by roasting, de-husking, and grinding.
- If used, grind sugar to a fine powder on a clean slate or in a mill.
- Mix 100 g of soya flour with enough honey, or powdered sugar and a little water, to make a candy like consistency. This amount is usually enough for 1 week for one colony.

Feeding

- Wrap in a clean perforated plastic bag and place on the top bar, being careful not to squash any bees.
- Leave in place until fully consumed. If made with sugar and water, check occasionally for signs of fungus growth and remove if necessary.

COMB FOUNDATION MANAGEMENT

Comb foundation is a sheet made of beeswax with an embossed comb pattern, which is used in modern beekeeping to help bees build regularly-shaped combs fast. Worker bees consume a large amount of honey and nectar when producing wax to build combs (estimates suggest 10 g of honey to make 1 g of beeswax), and it takes a considerable amount of time. Thus comb building reduces the productivity of the colony. Comb foundation speeds up the process by providing a wax base and a pattern that bees can use to start from when building a new comb. It must be used in the brood chamber frames, and can also be used in frames for the super chamber if no old combs are available for reuse. Different comb foundation is used for *Apis mellifera* and *Apis cerana* bees; foundation for the Newton hive (*Apis cerana*) has a smaller cell size and smaller sheets. Using comb foundation has a number of advantages.

- It helps production of straight regular combs.
- It is easier for beekeepers to inspect and replace combs.
- Honey can be harvested with a honey extractor (which requires straight combs) to give uncontaminated high quality honey; harvesting with an extractor is faster and doesn't break the combs so that they can be reused.
- Collection and storage of hive product is faster as the bees use the small volume of wax they excrete more efficiently.
- Combs are stronger and will not be damaged during migration.
- Drone production in a hive can be minimized as the foundation does not have the larger cells needed for drone rearing. When the bees want to rear drones, they adapt the foundation and make larger cells.

Installing comb foundation

- The foundation sheet should be placed in the groove of an empty frame, fixed with melted wax from a pot or burning candle, and the wires of the frame attached to the face of the comb with drops of melted wax or by pressing the wire into the comb foundation with a sharp heated knife or hive tool.
- Foundation is mainly used in the brood chamber and in or just before the honey flow season. If combs are needed in the super of a bee colony, it is best to use stored old combs, or to move honeycombs from the brood chamber to the super and place new comb foundation in the brood chamber.
- The frame with foundation can be placed at the centre or side of the hive according to the colony status and season. It should be placed at the side in a strong colony and at the centre in a weak colony. It is better not to provide foundation during the dearth season, but if needed, it should be placed at the side.
- In a strong colony, old combs or foundation should be added to the super shortly before the honey flow season. Two or more comb foundations can be supplied at the same time to a colony in the honey flow season.
- Comb foundation can be cut to fit the super chamber if needed.
- The colony size and external temperature should be taken into consideration when adding comb foundation.
- During the cold season, the comb foundation or stored old combs should be dipped in warm water before placing in the hive.

Storing comb foundation

New foundation

- Prepared comb foundation sheets should be wrapped in clean newspaper, with individual sheets separated by a piece of paper, and stored safely in a cool dry place for later use.

Old combs

- Wrap old drained combs still in the frame in newspaper. Store safely in a cool, dry place protected from fungi and insects. Make sure they are free from wax moth or other pests before reusing.
- After opening a packet of old combs, select ones that are reusable and air them in the open for 24 hours in a safe place.
- Immerse the combs in clean water for a short time, drain the water from the cells on both sides, dry in the shade, and then use.

QUEEN REARING

Introduction

The quality of a queen is very important for successful beekeeping. Continuous selection and multiplication of the best colonies is vital for genetic improvement. Colony characteristics such as population growth, pollen and nectar collection, storage capacity, disease resistance, and gentleness are all determined by the genetic quality of the queen. All the bees in the colony, including the male drones, are offspring of the queen; thus she is the only member of the colony to pass on genetic traits. Requeening colonies annually helps to keep them strong and healthy.

Queens are required for division of colonies or replacing old exhausting queens. Any bee colony when rendered queenless will raise one or few new queens. But raising queens in mass in a colony is a wise practice since bee colony looses more than a month with respect to egg laying and brood rearing and hence gives a big setback. Best time for queen rearing is when colonies are preparing for swarming and pollen and nectar stores and income are in plenty.

It is easy to produce queens on mass scale in a queenless or queen right colony by grafting technique. In case of queen right colony the queen is rmoved away from the queen rearing area by a queen excluder. Wax queen cups of appropriate size are attached to a bar made to fit in a special frame. Larvae of upto 24 hours age are grafted into the cell cups at optimum temperature and humidity conditions. Same colony can be use both as cell builder and cell finisher colony. Sealed queen cells are removed after 10 days of grafting and kept in queen nursery colonies or given to mating nuclei.

Requirements of Cell building colony :

(i). Enough honey stores or else should be fed with sugar syrup.

(ii). Enough pollen stores; it is useful to provide pollen supplements.

(iii). Bees overflowing in the hive.

After emergence and mating the queens can be shipped in queen cages. Ideal queen cage is a soft wooden block (2”x3”) with three cavities. Queen with few attendant worker bees are put in the cage and are provided candy in a cavity of the cage. The cavities are covered with a wire gauge screen, pinned to the wooden block. For queen introduction, about 3” long round cage of hardware cloth is ideal. Queen is confined in the colony in the cage and released after 24 to 48 hours. The queen will be accepted after the queen odour is familiar to the bees of the colony.

Artificial Queen Production

Queens can be produced artificially from a selected colony at a favourable time. The beekeeper prepares queen cells using beeswax and grafts 1–2 day-old larvae from the worker cells into the queen cells with the help of a grafting needle. The nurse bees feed royal jelly to the grafted larvae, take care of the cells, and prepare mature queen cells, which can then be separated and transplanted to a queenless colony or nucleus colony.

The ideal time for queen rearing is different in different parts depending on the specific geography and climatic situation. Ideally it should be carried out during the honey flow period and under favourable weather conditions (warm and dry). This means March to April and September to October in plains, hills, and mid-hills areas, and around June in mountain areas.

Colony selection for queen production

Each colony in an apiary should be numbered for easy record keeping. Records should be maintained of different functions so that the genetic characteristics can be evaluated. Selection of colonies to produce queens and drones should be based on the following qualities.

- Strong and healthy
- Gentle
- Low tendency to swarm and abscond
- Population grows even in the dearth period
- Good nesting behaviour, cover brood combs even in unfavourable seasons
- Resistant against pests and diseases
- High capacity for honey and pollen collection and storage

Selection of a queen cell

The colony may have several queen cells of different quality. The following should be considered when selecting a queen cell:

- Choose a queen cell that is being attended and protected by a large number of workers.
- Choose a cell that is long and cylindrical (bigger cells generally have better quality queens).
- Retain two queen cells of different maturity.
- Remove any other queen cells to control swarming.

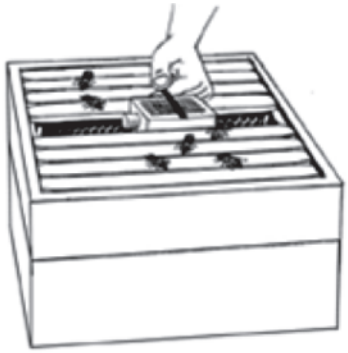
Requeening, queen release and replacement

If a new queen is placed directly in a colony she may be attacked and killed by the workers. The following methods can be used to avoid this.

Queening using a queen cage

- Remove all the queen cells from all the combs in a queenless colony.
- Make a queen-right colony queenless 24 hours before requeening.
- A queen that is going to be used for requeening should be kept in a queen cage with 5–6 attendant nurse bees and a cotton ball or pieces of cotton cloth soaked in honey.
- Place the queen cage with queen between brood frames in the colony.
- After 24 hours in the colony, give a few puffs of smoke and then release the queen from the queen cage.
- If the released queen is covered by worker bees or they start climbing on the queen or teasing the queen wings, then re-cage the queen for a further 24 hours.

Handling and caging a queen



Placing a queen in a colony

Grafting a queen cell

- Use a knife to carefully cut out a selected queen cell together with a small piece of comb. Remove a brood comb from the centre of the brood chamber of the queenless colony and cut a space the size of the cell and comb piece at the edge of the comb. Place the queen cell and comb in the space and fix in place with a bamboo needle.
- Inspect the colony every 2–3 days to confirm queen emergence and queen laying. If egg laying does not start within 15 days, remove the queen and either introduce a new queen, graft a new queen cell, or unite the colony with a queen-right colony.
- Sometimes, the new queen may lay unfertilized eggs as a result of the absence of drones during her mating flight and/or an unfavourable environment for mating, and drones start developing in the worker cells. If this happens, the queen should be removed and another queen or queen cell introduced, or the colony should be united with a queenright colony.

Miscellaneous Management :

Queen cell grafting

Moving Bees :

Flying bees return to their original location. Bee colonies can be moved by about a meter each day and by steps can be shifted to few metres. When the colonies are to be moved to ½ to 1 km then the colonies can be shifted directly during early spring, late fall or winter when few bees are flying or the bees are moved to 4-5 km away and brought back to the site to which the colonies are to be moved.

Transporting Bees : .

Bees can be transported in transport hives which accommodate 4-5 frames and have arrangement for ventilation through hardware screen pieces fixed on the top or side walls. Transportation is also possible in regular hives but it does not economize on the space in the transport, however strong colonies have to be transported in regular hives. The frames should be firmly secured by fixing nails; bottom board and inner cover are also firmly fixed to the brood chamber. There should be enough food for bees to last during transportation or couple days after transportation. Combs full of honey are liable to break and bees will be killed with dripping honey. Colonies when transported in hot weather should be given a light sprinkle of water drops though the screen. Examine the colonies after they settle down.

BEE PASTURAGE

Introduction and Importance

Bee pasture, or forage area, is the area containing the wild and cultivated plants, bushes, and trees that are the source of the nectar, pollen, propolis, and water needed to fulfil the daily needs of honeybees. Pasture is a primary requisite for beekeeping. Beekeeping can only be successful where there is abundant forage as both brood rearing and honey production require food in the form of honey and pollen. Honeybee colonies will abscond during times of dearth if they don't have food. The honey production potential of a colony is effectively a measure of the food storage capacity, which depends on the availability of nectar and pollen. Colony development is directly dependent on the year round availability of forage. When forage isn't available, the colony won't increase or produce honey, and supplementary feeding must be provided simply to maintain numbers.

Identification of Bee Flora

Beekeepers need to be able to identify what bee flora are available (both wild and agricultural) before establishing an apiary. A beekeeper has various possibilities for learning to identify which plants can serve as bee flora in general, and which are available close to the (planned) apiary, including

- training and experience,
- study of books, statistics, articles, published by botanists,
- study of a herbarium or plant collection and preserved plants,
- collection and identification of flowers in a lab by technicians,
- observation of flowers being visited by bees,
- study of foraging potential of the area, and
- laboratory analysis of the pollen contained in honey to identify the floral source (melissopalynology).

Preparation and Use of a Floral Calendar

A floral calendar should be prepared to record the availability of bee flora around the year in a specific area. The calendar describes the sources of nectar and pollen, the strength of the sources, the flowering time, and the duration of nectar and pollen availability. It shows the availability of bee flora as well as the dearth period, when pasture and feeding management can be carried out. Table --------shows an example of a simple calendar. When using the calendar to assess resources for a colony, note that *Apis cerana* bees can fly up to 2 km from the hive to forage, and *Apis mellifera* bees up to 3 km.

Bee flora availability in Higher hills (whole of Kashmir and higher reaches of Doda, Ramban, Banihal, Kishtwar Poonch and Rajouri districts)

Period	**Major bee flora**
March -April	*Brassica campestris* var. *toria*, *Prunus, Brassica, Trifolium, Robinia pseudoacacia, Taraxacum,Plantago, Spiraea, Veronica, Tulipa, Salix, Almond, Cherry, Rosa, Aesculus Acacia, Viburnum, Rubus, Acacia, Viburnum, Rubus, Juglans*
May - June	*Plectranthus rugosus, Wendlandia*, *Acacia, Brassica, Cabbage, Raddish, Impatiens, Stellaria,Rubus Geranium, Lonicera, Spiraea, Potentilla, Indigofera, Polygonum, Fagopyrum, Veronica*, *Tulipa, Iris, Garden flowers, Aesculus, Salix, Acacia, Tillia, Fruit trees, Rosa, Viburnum,*

July-August	*Zea, Trifolium, Indigofera, Polygonum, Fagopyrum, Impatiens, Geranium, Delphinium, Helianthus, Potentilla, Plector*anthus
September - October	*Zea, Trifolium, Polygonum, Polygonum, Stellaria, Geranium, Helianthus,Crocus, Plectoranthus*
November -December	*Crocus*

Bee flora availability in lower hills (parts of Doda, Ramban, Banihal, Kishtwar Udhampur, Poonch and Rajouri districts)

January - February	*Salvia, Salix, Viburnum, Rosa*
October-March	*Isodon rugosus*, *Brassica campestris*, *Wendlandia*, Toon
October-December	*Brassica campestris* var. *toria*, *Eucalyptus*
November-May	Litchi, berseem, sunflower
April-June	Litchi, *Citrus*, *Prunus*, Berseem. Acacia, cucurbits, *Adhatoda vasica*, *Indigofera, Trifolium, Medicago, Salvia, Nepeta, Origanum, Polygonum, Fagopyrum, Rumes, Chenopodium, Artemsia, Dipsacus, Spiraea, Potentilla, Fragaria, Geranium, Veronica, Plectranthus, Berbaris, Aesculus, Crotolaria, Rhododendron*, *Viburnum, Prunus, Pyrus, Rosa, Rhus, Rubus, Lonicera, Strobilanthes*
July - August	*Indigofera, Trifolium, Medicago, Polygonum, Fagopyrum, Rumex, Nepeta, Mentha, Origanum, Artemsia, Dipsacus, Inula, Potentilla, Geranium, Plectranthus, , Rosa, Dianthus*
August - October	*Ziziphus,* Maize, *Brassica campestris var. toria, Trifolium Medicago, polygonum, Fagopyrum, Rumex, Dipsacus, Geraniun, Olea*
February-March	*Brassica* sp., *Eucalyptus*, shisham, drumstick
December-March	*Brassica* sp., *Eucalyptus*, coriander
March-May	Jamun, *Indigofera, Astragalus, Salvia, Nepeta, Polygonum, Allium, Spiraea, Geranium, Viburnum*

Bee flora availability in plains (Jammu, Samba parts of Kathua and Udhampur)

January - March	*Brassica, Mangifera, Wendlandia*
March - April	*Bassica, Cassia, Sapindus, Toona, Citrus, Dalbergia, Mangifera, Phyllanthus, Opuntia*
May - June	*Carthamus, Indigofera, Sapindus, Dalbergia, Zizyphus, Cassia, Acacia, Grewia*
July - August	*Zea, Carthamus, Dipsacus, Cassia, Indigofera, Acacia, Zizyphus, Grewia*
September - October	*Sesamum, Zea, Carthamus, Dipsacus, Acacia, Zizyphus*
November - December	*Brassica, Bauhinia*

MIGRATORY BEEKEEPING

Introduction

In general, no one area will contain flowering plants all year round. However, honeybees need to collect nectar and pollen to meet their daily needs and to produce honey, and need supplementary feeding if no pollen and nectar are available. Thus it is useful to move colonies to different areas according to the flowering calendar. This is called migration, and when practised on a large scale is called migratory beekeeping. Migration can also be carried out primarily for pollination of fruit trees or other agricultural crops with honey production a secondary consideration.

Colony migration is usually an essential part of commercial beekeeping. The main objectives are to

- increase honey production,
- strengthen and divide colonies,
- reduce the cost of supplementary feeding,
- increase crop productivity through bee pollination, and
- help conserve biodiversity (agricultural and wild plants) through pollination.

Points to Consider

The main objective of beekeeping is to maximize honey production and minimize production costs. Thus beekeepers should first identify suitable bee pasture, know the costs of migrating, and migrate colonies with the proper technical knowledge and skills. The following points should be considered when planning migration.

Migration site selection

- Identify the type of floral sources, season and duration of blooming, and area of pasture and carrying capacity at the home site and possible migration sites.
- Collect information about the local environment and possible use of pesticides for crop protection in the bee pasture area.
- Investigate the likelihood of attack by natural enemies; only migrate colonies to places where the chance of attack is low.
- Estimate the distance of bee pasture from the apiary where the colonies will be located. Find out about the availability of transport to the possible sites for the apiary.
- Analyse the total costs and benefits of migration.

Selection and preparation of colonies

- Select only strong, healthy, and productive colonies for migration.
- Strengthen the bee colonies for at least two months before migration.
- Collect together all necessary materials, for example supers, frames, comb foundation, honey extractor, and vessels for collecting honey.

Timing of migration

- Migrate the colonies when flowering of major bee plants has started and at least 5% are in bloom.

Migrating an apiary

a) Sealing the hive entrances after nightfall

b) Don't close the entrance during the day

c) Colonies prepared for migration

d) Loading colonies on a vehicle

e) Migrating colonies at night

f) Removing the belts around the hives at the destination

h) Inspect the hive to see if hees are flying in and out normally

i) Two days later, open the hive to inspect the colonies

Preparation

Honeybee colonies should be prepared carefully for migration. If the preparation is not done properly, some bees may be left behind or may die during migration. Preparation includes the following:

- Clean the hives.
- Harvest excess honey and remove the super. Bees can die if migrated with honey stored in the hive. Fix frames tightly in the hive.
- Arrange supplementary feeding if migration is over a long distance.
- Seal all cracks and crevices to prevent the bees escaping.
- Fix the bottom board to the brood chamber, and the brood chamber to the super by nailing strips of wood from top to bottom. Use a wire netting inner cover nailed to the brood chamber to give more air if there is
- danger of overheating, especially during summer; remove the outer cover for long distance migration in the hot season.
- Hives can be tied with a hive belt, wire, or rope without removing the outer cover for short distance migration of a few colonies.
- Narrow the ventilation to prevent excess cold air entering the hive when migration is in the cold season.
- Close the hive entrance after all the bees have entered the hive in the evening using a cloth plug or nailed down wire netting. If bees are clustering at the entrance, they can be encouraged to enter by spraying water or giving a puff of smoke.

Migration

- Colonies can be migrated by truck, tractor, rickshaw, manually by porters, or a combination of these, depending on the location of the original and new pasture areas and the weather.
- Colony migration should be carried out at night if possible (in winter between 5 pm and 10 am and in summer between 7 pm and 7 am).
- Ensure that air can circulate between hives.
- Carefully load and secure the hives. A vehicle should go slowly and as smoothly as possible.
- Vehicles should not stop for long periods. If they have to stop for a whole day or more, unload the colonies, open the entrances to allow bees to go out to forage, and repack and reload after nightfall.
- Carefully unload the colonies one by one at the destination.
- Place the colonies in a group (the apiary) with at least 5 feet (1.5 m) between hives.
- In general, place so that the entrances face southeast, unless the direction of the forage area, or weather and wind direction, make a different orientation preferable.
- After setting up the hives, open the colony entrances one by one by removing the cloth plug or the nailed hive net, starting at one end of the apiary and moving to the other.
- Thirty minutes after the entrances are open, or as soon as it is day, inspect the flight condition of the colonies from outside. Inspect inside after 2 days unless there is no

flight, low flight, workers wet with honey, dead bees, or bees crawling on the ground, in which case the colony should be inspected immediately and the appropriate action taken.

- Inspect the hives every few days. Replace the super on the hive once the brood chamber is full, using old combs or comb foundation in the frames.

Migratory beekeeping in J&K

The *A. mellifera* colonies are generally used in migratory beekeeping and several thousands of such colonies are transported yearly to increase honey flow. The *A. cerana* colonies are usually not used in migratory beekeeping and mostly kept in wooden logs or modern bee hives. The Doda, Ramban, Banihal, Kishtwar and Udhampur Districts of Jammu region and Anantnag district of Kashmir are the most potential and suitable areas of beekeeping. There can be possibility for beekeeping at moderate level in other districts such as Kathua, Jammu, Rajouri, Poonch, Pulwama, Baramulla, Srinagar and Kupwara. Ladakh and Leh areas of the state are not suitable for beekeeping. Though beekeepers are undertaking migration for production, there is a great scope to increase the efficiency and improve honey production. This can be facilitated with knowledge of floral resources and evolving appropriate migration schedules for different beekeeping regions. A detailed study of the floral resources for *A. mellifera* in J&K and seasons for honey production in different regions has been presented (table 2). The flora required for beekeeping is available round the year and provides sufficient bee forage for production of honey and other products of commercial value. All this makes it best fit for both migratory and stationery beekeeping.

Table 2. Migratory sites and major bee flora in areas of the state for optimal utilization of floral resources

Migration site	**Period**	**Major bee flora**
Higher hills (whole of Kashmir and higher reaches of Doda, Ramban, Banihal, Kishtwar Poonch and Rajouri districts)	February -April	*Brassica sp., Trifolium sp., Robinia pseudoacacia, Prunus, Rosa, Acacia, Rubus*
	May - June	*Acacia, Brassica, Raphanus, Fagopyrum, Acacia sp.*
	July -August	*Zea, Trifolium, Indigofera, Helianthus, Plectranthus*
	September - October	*Zea, Trifolium, Helianthus, Crocus, Plectranthus*
	November -December	*Crocus*
Lower hills (parts of Doda, Ramban, Banihal, Kishtwar Udhampur, Poonch and Rajouri districts)	January - February	*Salvia, Salix, Viburnum, Rosa*

	October-March	*Isodon rugosus*, *Brassica campestris*, *Wendlandia*, Toon
	October-December	*Brassica campestris* var. *toria*, *Eucalyptus*
	November-May	Litchi, berseem, sunflower
	April-June	*Litchi*, *Citrus*, *Prunus*, *Acacia*, cucurbits, *Adhatoda vasica*, *Pyrus, Rosa, Rubus sp.*
	July - August	*Trifolium, Medicago, Plectranthus, Dianthus*
	August - October	*Zizyphus,* Maize, *Brassica, Trifolium, Olea sp.*
	February-March	*Brassica* sp., *Eucalyptus*, shisham, drumstick
	December-March	*Brassica* sp., *Eucalyptus*, coriander, Fennel,
	March-May	Jamun, *Indigofera, Allium*
Plains (Jammu, Samba parts of Kathua and Udhampur))	January - March	*Brassica, Mangifera, Wendlandia*
	March - April	*Brassica, Cassia, Citrus, Dalbergia, Mangifera,*
	May - June	*Dalbergia, Zizyphus, Cassia, Acacia, Grewia*
	July - August	*Acacia, Zizyphus, Grewia*
	September - October	*Sesamum, Zea, Acacia, Zizyphus*
	November - December	*Brassica, Bauhinia*

MIGRATION routes of beekeepers

Interstate Migration

The beekeepers migrates colonies from Jammu to farms of *Sorghum, Eucalyptus*, *Brassica* and *Cajanus cajan* crops (10-15kg honey/colony) in the plains of Uttar Pradesh (Aligarh) during ending October to end of December (Table 3). The colonies are then migrated during ending November/December to Mid of February in Alwar and Kota areas of Rajasthan for flow from sarson (20-25kg honey/colony). Colony development and breeding is done during mustard blooming. Half of the mustard flow and other blooms are utilized for honey extraction. Beekeeper reports an average 1:1 colony multiplication during these migrations. Generally colonies ranging 250 to 300 are migrated in single truck and cover a distance of 300 to 800 km. The colonies are migrated during February to March in areas of Bara (Kota) in Rajasthan for *Coriander* flow (10-15kg honey/colony), or Saharanpur in western Uttar Pradesh for the mustard and *Eucalyptus* flow (5-10 kg honey/colony). The colonies taken to plains of Uttar Pradesh are then brought back during March-April to locations around Jammu to utilize the flows from the multiflora (5-10 kg honey/colony). After the multiflora season, colonies from the Jammu area are migrated to

Srinagar (Pampore) for forage from saffron (8-10 kg honey/colony) in April-July. The colonies from Jammu can be migrated to locations around or near Srinagar for *Robinia pseudoacacia* during March-April. This species is dependable source of nectar and colonies can produce surplus honey. Some beekeepers migrate their colonies to local areas of Jammu for flow from berseem (5-6 kg honey/colony) in April - May and from *Acacia*/*Toona* in June- July. Colonies in some cases are further shifted to Banihal and Ramban areas during June to October to utilize the flows from the *Plectranthus* or upper elevations for flow from buckwheat during June to September. The colonies are brought back to Jammu during ending October to November to utilize the flow from toria and ber (10-15 kg/colony). Some beekeepers practice only one migration. They migrate their colonies to Ganga Nagar (Rajasthan) flow from mustards (20 kg honey/colony) during Ending November to mid of March and brought back their colonies during March-Ending to locations around Jammu to utilize the flows from jamun, neem, eucalyptus, berseem, mustard, shisham (15-20 kg honey/colony). The beekeepers are able to harvest 50-60 kg honey/colony/year which is about five times more than obtained with stationery beekeeping. In addition, beekeepers could increase their colonies by at least 20 per cent and save the maintenance cost during dearth period. The strength of the colonies also improved by migration more conveniently than by artificial feeding at one place during dearth period and the duration of the dearth period is also minimized.

Table 3 : Migration pattern of beekeepers of the state

Area of migration	**Period**
OUTSIDE THE STATE	
Banihal, Ramban	June - Ending October
Jammu	Ending October-November
Aligarh	Ending October - End of December
Rajasthan (Alwar, Kota, Ganga Nagar)	Ending November / December – Mid February
Rajasthan (Ganga Nagar)	Ending November - Mid March
U.P. (Saharanpur)	Mid February - Mid March
Bara (Kota; Rajasthan)	Mid February - Mid March
Jammu (Purmandal, Bishnah, Miran Sahib, R. S. Pura, Ghou Manhasan)	Mid March - Ending May
Jammu (higher reaches of Reasi, Samba, Udhampur, Rajouri)	June - July
Srinagar, Anantnag	March - July
WITH IN THE STATE	
Jammu (R. S. Pura, Bishnah, Purmandal), Samba (Mansar, Raya Morh, Dhiansar), Kathua (Chadwal, Billawar, Dayalachak) and Udhampur (Chenani)	December - March
Upper reaches of Jammu, Samba, Kathua, Rajouri, Poonch and Udhampur	April - June
Doda, Banihal and Ramban districts	June-August
Upper reaches of Sunderbani (Rajouri) and Nowshera (Poonch) areas	April - July
Srinagar, Anantnag, Quazigund, Pulwama, Pampore	May-June

Within state migration

Several vegetation regions with in the state exhibit short/long gap of flowering. Migratory beekeeping can be practiced to overcome these deficiencies in bee forage availability. The migration between hills and plains is a routine procedure adopted by commercial beekeepers of the state. Inter migration between the plains, lower and upper hills help cut down these losses (Table 3)

Beekeepers under stationary beekeeping kept an average of 22.85 bee colonies, incurring a cost of about Rs. 442.50 per colony, while those practicing migratory beekeeping with in the state and outside the state kept 39.00 and 165.75 bee colonies and spent about Rs. 787.50 and Rs. 1300 per colony, respectively. Honey production was an average of 9.35 kg/colony in the stationary beekeeping while it was 34.50 and 17.50 kg/colony in the outside and with in state migratory system of beekeeping, respectively. The net returns were Rs. 445.75, 875.00 and Rs. 1812.50 in the stationary beekeeping, with in state and outside state migration, respectively. This shows that differences in cost structure are marginal between the three types of beekeeping but due to higher honey yield net returns are almost three times higher in case of migratory bee keeping. In Himachal Pradesh, beekeepers harvest 15.66 and 41.60 kg of honey/colony/year from stationery and migratory beekeeping, respectively (Sharma and Bhatia, 2001). While in Bihar, the honey yield is highest as compared to other states with a production rate of 40 and 60kg/hive/year under stationery and migratory *A. mellifera* colonies, respectively (Bansil, 2011). Deodikar and Thakar (1966) discussed the aspect of migration of bee colonies from forests in hills to farms and orchards in the adjacent plains in order to utilize the local bee flora and improve bee forage availability to bee colonies. Chaturvedi *et al*. (1969) stated that migratory beekeeping in the Kumaon region of Uttrakhand could enhance honey production and colony multiplication. Ahmad *et al.* (1984) developed schedules for migration of bee colonies of profitable honey production (16.08 kg/colony) compared with non migrated colonies (2.8 kg/colony) with 60 per cent mortality of the colonies during dearth season. Sihag (1990) suggested migration as an important beekeeping practice for *A. mellifera* in Haryana. Singh *et al*. (1998) suggested certain migratory routes for honey production and colony multiplication in Bihar, India. Gatoria *et al*. (2001) gave a brief account of examples of some routes followed by beekeepers practising migratory beekeeping in different parts of the country.

DISEASES AND ENEMIES OF HONEYBEES

Honeybees are affected by many viral, bacterial, fungal and protozoan organisms. Prevention and control of honeybee diseases has been an essential aspect of management. Due to the presence of brood, adults, honey, pollen and wax in the colonies/nests, they are very attractive to pathogens and enemies. Additionally, their trophyllaxis, absconding, swarming, robbing, drifting, foraging and shifting/migration, etc. Behavioural characteristics help in very easy and fast spread of the diseases or pathogens within a colony, colony to colony and place to place.

1. Brood diseases : bacterial diseases, fungal diseases ,viral diseases
2. Adult bee diseases : protozoan diseases, bacterial diseases and viral diseases.
3. Mixed infections
4. Non infectious disorders : neglected brood, chilled brood, overheated bees, genetic lethality ,plant poisoning, pesticidal poisoning.
5. Honeybee mites
    i. Parasitic
    ii. Endoparasitic, *Acarapis woodi*
    iii. Ectoparasitic *Tropilaelaps clareae, T. koenigerum*, *Varroa jacobsoni, V. destructor*
    iv. Stored product mites
    v. Phoretic mites
6. Pests waxmoth as, bee louse, hawk moths
7. Predators wasps ,birds, small mammals.
8. Enemies: ants, toads, spiders, dragon flies, squirrels.

Brood and adult diseases of honeybees, their causative agents and occurrence in India.

Disease	**Causative agent**	**Symptoms/colour of the brood**
Brood diseases		
American foul brood (AFB)	Bacteria*, Bacillus larvae*	Dull white dead brood becoming brown to white
Europen Foulbrood (EFB)	Bacteria, *Melissococcus pluton*	Dull white dead brood turning yellow to dark brown
Sac brood disease (SBV)	Virus, *Morator aetatulus*	Grayish or straw coloured becoming brown, grayish black or black or black head or black head end darker
Thai Sac brood virus disease (TSBV)	Virus *Morator aetatulus* (Thai Strain)	Grayish or straw coloured becoming brown, grayish black or black or black head end darker
Chalkbrood disease (CB)	Fungus, *Ascosphaera apis*	White chalklike mass sometimes referred to as mummy.
Stone brood (SB)	Fungs; *Aspergillus flavus*	The fungus forms a characteristic whitish yellow color like ring near the head end of the Infected larvae after death. Infected larvae become hardened and difficult to crush, hence called 'Stone brood'

Adult diseases Nosema disease	Protozoan, *Nosema apis* *Nosema ceranae*	Shining swollen abdomen Shining swollen abdomen
Amoeba disease	Protozoan, *Malpighamoeba mellificae*	Cysts in Malphighan tubles
Bee paralysis	Filterable virus	Black hairless shiny bess
Septiceamia	Bacterium *Pseudomonas apiseptica*	Destruction of connective tissue of legs, wings, and antennae
Clustering disease	Iridescent bee virus	Bees leave combs and form clusters on the wall of hive or outside the hive become sluggish, queen stops egg laying and drawlers appear around the colony.

Occurrence of various pests, predators and enemies of honeybees in india

Category enemy/animal	**Disease/enemy**	**Causative agent**
Moths	*Achroia grisella*	Lesser wax moth
	Galleria mellonella	Greater wax moth
	Acherontia styx	Hawk moth
Pseudoscorpion	*Ellingsenius indicus*	False scorpion
Birds	*Meropes orientals*	Predatory bird
	Meropes apiaster	Predatory bird
	M. superciliosus	Predatory bird

Table : Occurrence of various species of mites associated with honeybees

Mite species	**Mite species**
Acarapis woodi (Endoparasitic mite)	*Tropilaelaps clareae* (Ectoparasitic mite)
Varroa jacobsoni (Ectoparasitic mite)	*Tropilaelaps clareae* (Ectoparasitic mite)
Varroa destructor (Ectoparasitic mite)	*Tyrophagus longior* (provision mite)
Euvarroa sinhai Ectoparasitic mite	*Neocypholaelaps indica* (Phoretic mite)

Predatory wasps of honeybees and their occurrence in India.

S. No	Predatory Wasps	Common name
1.	*Vespa orienatlis*	Golden wasp
2.	*Vespa velutina*	The giant wasp
3.	*Vespa magnifica*	The giant wasp
4.	*Vespa cincta*	The yellow banded wasp

Brood Diseases

Honeybee brood suffer from variety of diseases. Loss of brood affects the colony strength. Adult bees are not affected by brood diseases by they can spread the casual organisms. Brood diseases are more serious than adult diseases. Thai sac brood viral disease has been very serious in *Apis cerana indica* in north India during 1980-1986 and loss of upto 95 per cent colonies is reported. But the virus does not infect mellifera colonies. Sac brood disease is encountered in western countries in *A. melifera* colonies but there is no report from India. Fungal brood diseases (stone brood and chalk brood) are not of frequent occurrence and these have not been encountered in India.

For ascertaining brood infection, it is important to observe

- Age of brood at death
- abnormality in cell capping
- shape and position of dead brood
- colour of the dead brood
- scales of dried dead brood
- odour of the decaying brood and
- type (worker / drone / queen) of brood affected.

Key to Determination of brood diseases

	American Foul Brood	European Foul Brood	Sac Brood / Thaisac Brood
Time of death	Late larval or early pupal stage.	Coiled larvae in unsealed cell and rarely late larval.	Late larval stage.
Appearance of cell capping	Cappings sunken and usually have holes; many are removed.	Some cappings perforated.	Cappings removed or punctured.
Consistency	Off white to light cream to brown to dark brown and finally black.	Yellowish to grey or brown and finally dark brown.	Straw coloured; starts darkening from head.
Position of dead brood	Extended on the cell base.	Coiled, twisted or collapsed.	Extended with head curried up.
Consistency	Toothpick stirred into decayed larva and slowly withdrawn there is ropiness.	Soft and gummy but no ropiness.	Tough larval skin with watery or granular contents.

Odour of dead brood	Putrid-faint	Strong and sour	Faint-sour.
Appearance of scale of dead larva	Dark, thin and brittle, adheres to cell walls.	Irregular in colour, thick, easily removed from cell.	Tough and brittle, dark, very loose in cell.
Brood affected	Worker, drone and queen.	Worker, drone and queen.	Worker only.

Adult bee diseases and enemies

Adult bees are affected by nosema, virus diseases and acarine mite in India. Nosema and acarine diseases are widely spread in India. Some viral diseases have been reported but iridescent virus was the most serious in *Apis cerana indica* in 1970's. Diagnosis of adult diseases is difficult in the initial stages and is possible only when large number of crawlers or dying bees are observed near the hive. Some of the points which should attract bee keeper's attention are (1) Time of the year (2) Extent of effect (3) Behaviour of affected bees (4) Position of wings of crawler bees (5) Egg laying and brood rearing.

Key to Determination of adult diseases / poisoning

	Nosema	**Acarine**	**Irido Virus**	**Pesticidal poisoning**
Time of year	Late spring	Early spring	Spring to summer	Just after application
No. of colonies affected	Few to many; many crawing and dead bees.	Few to many; many crawlers and dead bees.	Few to many.	Almost all, can be large no. of dead and dying bees.
Behaviour of affected bees	Crawlers on leaf blades, stuggish. Abdomen distended and dysenteric bees.	Many crawlers.	Bees listless, cluster on outside or inner hive walls, sting heavily. Stop rearing brood.	Uncoordinated movements of bees, paralytic with distended abdomen trembling, dying at the hive or in field.
Age susceptible	Older adults.	Older adults.	All bees.	Bees of all ages; even brood is affected when poisoned pollen is stored and fed to larvae.

Control of tracheal mite

- Use of folbex strips (a mixture of potassium nitrate and 500 mg. of chlorobenzilate) as a fumigant at the rate of 1 ½ - 2 strips per colony.
- Use of menthol crystals @ 50 g per two – story hive effectively controls mite infestation.
- Use of apistan (fluvalinate) strips can also control acarine disease.
- Use of menthol strips (300 mg) is effective.
- Use of formic acid, 5ml of 85% was also effective.

Control of Varroa mite

- Regular monitoring of colonies is essential.
- Application of sulphur, formic acid and laitic acid were found effective.
- Synthetic pyrethroids *viz.,* Fluvalinate (Apistan) and Flumethrin (Bayvarol) are commonly used. Their fumes are released from impregnated strips of plywood or plastic. High mortality of mites is achieved within 6 – 8 weeks.
- Two strips of Apistan or four strips of Bayvarol are used per colony.
- Synecar, a mixture of sugar powder + chloropropylate or bromopropylate @ 100 mg per colony depending upon the colony population is dusted in between the frames.
- Thymol 0.25 g powder dusted in passages of frames is also found effective.
- Oxalic acid (3.5%) when applied as spraying or trickling in the form of sugar solution is effective.

Management of Viral diseases

There is no specific and control measure for TSBV and SBV because virus becomes part of the host cell. However, following measures can help in minimizing the possibilities of further spread of the disease :

- Keep colonies strong and exercise check on robbing, absconding, drifting and exchange of combs and equipment.
- Adopt general colony hygiene like frequent cleanliness of hives, handling of diseased and healthy colonies separately during manipulation, honey extraction, etc.
- Avoid hiving stray swarms.
- Isolate healthy colonies from infected ones.
- Create bloodlessness in colony by caging queen for 15 days.
- Check the colonies periodically for any abnormality.
- Destroy the severely infected colonies and combs.
- Multiply disease resistant colonies.
- Replace queens from diseased colonies with newly mated ones.
- Disinfect empty equipment and combs by soaking in a detergent (surf excel, 1%) solution containing 1% formalin for few hours. Then wash them with fresh water, dry and use, or Disinfect the empty and dry combs with UV- rays ach side for 20 min in protected chamber.
- Feed a dose of oxy tetracycline or ciprofloxacin @ 200 mg (5% a.i., vet. grade) per colony in sugar syrup (50%) to prevent secondary infection.

Control of foulbrood diseases

- Keep colonies strong with good egg laying queens.
- Isolate healthy colonies from diseased ones.
- Maintain colony hygiene. Prevent robbing, absconding, migration and drifting of bees.
- Select and multiply diseased resistant colonies.
- Kill the heavily infested colonies with about half pint of petrol by pouring in the top of

the closed hive. Burn these alongwith brood combs in a pit (45 cm deep and wide enough) and afterwards fill it with soil. Remove the debris by scratching bottom boards, hive bodies, inner covers or outer covers, collect and burn in a pit. Flame the hives and equipments with blow torch.

- Disinfect the hives, combs and equipment with ethylene oxide (1 g/ lit) for 48 hours at 43^0C in fumigation chamber. Reuse the material after proper aeration, or Sterilize the empty and dry infested combs with UV- rays for 20 minutes.
- Dust tylosin tartarate or lincomyacin hydrochloride @ 200mg in 20 mg sugar powder /hive between the combs at weekly interval or feed oxytetracyclin @ 250-400 mg / 5l sugar syrup (50%)/ colony**.**

Control of Nosema

- Overwinter the colonies with good strength and adequate food reserves.
- Keep the colonies in open sunny sites.
- Provide fresh and clean water in the apiary.
- Re-queen the colonies with newly mated queens.
- Give temperature treatment to the empty equipment at 49°C and 50% RH for 24 h for destroying spore, or sterilize the equipment and empty combs by fumigating with 80% acetic acid @ 150 ml/hive space in stacks for few days. Reuse them after proper aeration.

Chemical treatments to the colonies should be avoided. If necessary, it should be given only when there is a long dearth period (>30 days) and honey should not be extracted from the treated colonies

Wax Moth :

Two species of wax moth viz. Greater wax moth (*Galleria mellonella* L.) and Lesser wax moth (*Achroia grisella* F).are found causing considerable damage to honey bee colonies and frames in storage. Moth lays eggs on the stored combs or on the spare combs in the colony. Larvae develop by feeding on wax and pollen in comb cells. Wax moths are most active in summer, rainy season and fall.

Management :

- Regular inspection of bee hives.
- Though any colony is prone to the attack of wax moth, strong colonies are able to resist it.
- Keep the hives without cracks and crevices.
- Hive entrance should be reduced which can be effectively guarded by bees.
- Removal of all combs which are not covered with bees, especially during dearth periods.
- During the normal examination of colonies, the debris on the bottom board should be scrapped and cleaned with hive test.
- Tunnels of larvae in combs can be seen if it is held against the Sun rays. The larvae can be killed in the initial stages and silken webs are cleaned.
- All stages of wax moth are killed in combs at 46°C for 70 minutes .

- Sulphur dusting on the top bars of comb frames in hive body is suggested.
- Sulphur smoldering at 180 g per one cubic meter of space on a stack of 4-5 hive bodies in air tight condition in store. Fumigants such as acetic acid calcium cyanide, ethylene dibromide, pardichlorobenzene and phosphine have been used in different countries to protect honeybee products, especially combs from moths during storage

Wasp management

Wasp can be effectively managed by:

- Strengthening of the bee colonies and reducing the size of the hive entrance and alighting board.
- Fitting of queen gate or queen guard board.
- Mechanical destruction of the wasp colonies by kerosene torches, $CaCN^2$ fumigation, carbaryl spraying.
- Physical killing of the wasps by flappers
- Physical barriers: use wire gauge and bird scaring ribbons.
- Baits/feeding attractants. e.g. Cypermethrin + rotten fish/Chicken or Cypermethrin + pear/ apple/ pumpkin/ banana/ pinapple or Cypermethrin + sweet candy or Fruit juice (Grapes juice fermented for three days) Mutton +0.075% diazinon.
- Anti wasp campaign should be taken on community basis.

Management of fungal diseases

- Bee stocks selected for hygienic behavior can be expected to minimize outbreaks of this disease
- Hives that are drafty, damp, lying in low spots, or heavily overgrown with vegetation are susceptible to fungal diseases. Hives should lean forward slightly so that rain water runs out the entrance instead of accumulating inside.
- Old equipment should be replaced or repaired if it has large gaping holes that permit entry of moisture and drafts.
- old combs may harbor spores of the disease that persist to trigger the disease season after season and so should be replaced periodically to improve brood production.

PESTICIDES AND BEES

Pesticides have become synonymous with modern agriculture. Besides increasing agricultural production, these chemicals are also of immense value for the control of insect borne diseases of human beings. However the use of pesticides is accompanied by a variety of undesirable environmental effects including the effect on non target species. Bees and flowering plants are interdependent forming a mutually compatible system. Bees are the best pollen carriers and play a vital role in ensuring the productivity of crops. Hence, use of poisonous agro chemicals has become inevitable in scientific farming. While taking managerial decisions for sustaining crop productivity by employing pesticides, bee safety must be ensured.

Farmers apply large quantities of pesticides and they are unware of their hazards to insect pollinators and other beneficial insects. Killing of bees by pesticides is the most discouraging facet of apiculture in India as also in other countries.

Symptoms of Bee Poisoning

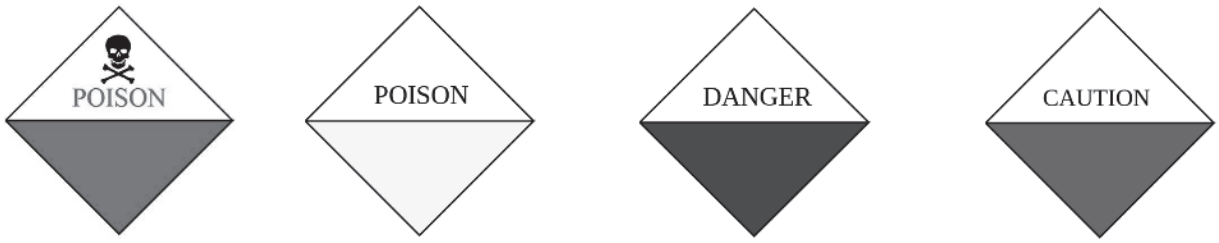
Bees come in contact with pesticidal deposits while foraging on sprayed crops or weeds where pesticides reach by drifting. The nectar and pollen can also be contaminated with pesticides and there can be stromach poisoning to bees and also to brood when fed on contaminated pollen. Some pesticides may even cause hazards by fumigant action. After gaining entry into body, different pesticides have different modes of action. Followings are some common symptoms of pesticidal poisoning in bees.

- A very common symptom of bee poisoning is the appearance of large number of dead bees in front of the hive. Some bees die in the field.
- Bees become paralytic, loose the power of orientation, legs, wings and digestive tract stop functioning and poisoning bees show uncoordinated movements.
- Bees often die with their lapping tongue protruded out
- Abdomen become distended.
- Bees exhibit abnormal and jerky movements
- Bees may spin on their back
- Bees may exhibit hopping flight and crawling
- Bees stop hive cleaning duty
- Bees becomes more aggressive.
- Regurgitation of contents of gut is noticed, particularly in case of phosphatic pesticidal poisoning.
- Guard bees are confused.
- Brood chilling can occur due to reduction in the population of adult bees.
- Dead brood can be seen inside the colonies, if poisoned pollen is stored and fed to brood.
- Pollen contamination and lack of warmth (brood chilling) may result in the brood death
- Nurse bees feeding an contaminated pollen stop secreting royal jelly
- Affected queen may lay eggs irregularly
- Sometimes the queen may stop egg laying totally leading to a break in brood cycle

- Queen cells may be raised and queens may be superseded in colonies which survive.
- Sometimes queenlessness may develop.

Figure: Symptoms of pesticide poisoning

Pesticide classification based on hazard level (GoI 1971)



Red	Yellow	Blue	Green
Extremely hazardous	Highly hazardous	Moderately hazardous	Slightly hazardous

Insecticides groups	Poisoning symptoms
Carbamates	Erratic Stupefaction Paralysis Break in brood cycle Queen ceases egg laying Supersedure queen bees Most bees die at colony Sevin specifically cause in ability to fly
Organophosphates	Regurgitation Disoriented Distended abdomens Erratic Wings hooked together held away from body Tongues extended Death
Synthetic Pyrethroid	Regurgitation Erratic Paralysis Many bees die between foraging area and colony
IGRs	Queens became drone layers Supersedure Death of larvae & production of undersized workers

Factors influencing bee poisoning

Stage of the crop

Crops are highly attractive to bees during the flowering phase. Hence, most severe bee poisoning problems involve blooming plants. Application of insecticides on flowers is highly hazardous to bees.

Type of formulation

The formulation of an insecticide has a lot to do with its hazards to bees. Liquid formulations are safer than wettable powders applied as sprays and wettable powders are safer than dusts. Granules and seed dressing chemicals are the safest formulations.

Time of application

Honey beef are diurnal insects. Hence, application of pesticides in late evening or night spare the bees.

Method of application

Aerial application of pesticides can result in more bee kill than ground application. Likewise coarse sprays are more harmful than fine sprays. Application of granules in the soil or central whorl does not affect bees. Systemic insecticides applied during flowering stage may contaminate pollen and nectar.

Nature of the pesticide

The toxicity of pesticides vary greatly according to their nature. Persistence and residual action greatly influence their toxicity.

Protecting bees from Pesticidal Poisoning

- Read the pesticide label. Pesticides and formulations which pose a special hazard to bees are required to include a notification on the label.
- Choose an insecticide of low toxicity to bees that will provide the needed pest control.
- Do not apply any pesticide unless the crop is so heavily infested that treatment is worthwhile. If the application of pesticide is necessary then use those insecticides which are non-toxic or less harmful to bees.
- Whenever possible, do not treat crops in bloom. If treatments are needed during bloom, choose a short-residual material. Make applications during the evening, when fresh pollen is enclosed within anthers and protected from insecticide contamination.
- Dust and wettable powder formulations tend to be more hazardous to bees than granules and emulsifiable concentrates. It is necessary to choose less hazardous formulations whenever available. Emulsions have a shorter residual toxicity to bees and granular formulations are less hazardous. Oily formulations are more dangerous and should be avoided.
- Apply pesticides when bees are not actively foraging. Honey bees are active primarily during the morning and early afternoon. Many pesticides can be effectively applied in the late afternoon or evening with relative safety to bees. Evening treatments may also help control the moths (adult stage) of many sweet corn pests that are active and laying their eggs at night.
- Ground applications are safer than aerial applications, the danger of drifting being reduced in the former.
- Minimize spray drift onto adjacent crops or other plants in bloom.
- Pesticidal dusts and small granules should not be left open or carelessly thrown anywhere because bees are likely to collect such dusts during acute pollen dearth period.
- Use of repellents for reducing the hazard of insecticides has been investigated for more than 90 years. An effective bee repellent must be strong enough to overcome the natural plant attractiveness and prevent honey bees from foraging on plants treated with a toxic insecticides.. The possibility utilizing neem oil mixed with insecticides could be considered to repel the bees till the residual effect of pesticides is reduced to sub lethal level.
- Honey bee hives should not be placed next to fields or orchards that are likely to be treated with pesticides toxic to bees.
- Beekeepers should inform farmers of the location of hives.
- Farmers should inform the beekeepers before applying pesticides and the beekeeper should either remove the colonies or should keep the bees confined inside the hive during the application. While confining bees due attention should be paid to the following points.

    a. Providing sufficient space in hive; while confinding the bees in the hive proper space for all the bees including foragers should be available.

b. Providing proper ventilation : Ventilation must by provided at the top and / sides of the hive, not only through the entrance, because this may get blocked by dead bees. ventilating screen should have as large a mesh as possible.

c. Shading hives : Shade is usually provided by the use of local materials. It must not hinder the flow of air past the hives.

d. Covering hives with wet absorbed matting : Covering the hives with wet clothes / gunny bags can be of great benefit, because evaporation of the water helps to reduce the rise in colony temperature. If pesticides are applied from the air, it is important to cover whole of the hive; otherwise it may be sufficient to drape a very wet cloth over the flight entrance. This greatly reduces flight activity of bees that fly out but it does not prevent flight entirely.

e. Providing water inside the hives : This water is taken by the bees and spread out in the hive, where it evaporates and thus reduces the temperature.

f. Minimizing the period of confinement : The confinement must of course continue as long as the pesticide near the hive retains unacceptable toxicity and its duration can satisfactorily be reduced only if the pesticide applied does not have long residual action. If there is no store in the hive then pollen supplement and sugar syrup may also be provided.

When the damage to bees (and also to brood) is due to pesticide contaminated pollen being carried back to the hive, two actions viz. prevention of pollen being stored in the hive and provision of a safe pollen supply inside the hive by the beekeepers may be helpful. Provision of pollen cakes in the hive during this period greatly reduces the collection of toxic pollen. Cakes of pure pollen were more effective than pollen supplement make with soybean flour.

Care of the Poisoned Colonies :

- Shift the bee colonies away from foreging range, from the source of poisoning.
- Provide sugar syrup and pollen substitute because most field force must have been killed.
- Contaminated pollen stored in combs can be removed by dipping the combs in water and washing by slight shaking.

Highly Toxic Pesticides

Abamectin (Agri-Mek) Admire, Provado (imidacloprid) acephate (Orthene, Address) Agri-Mek (abamectin) avemectin (AVID) Altacor/Coragen (chlorantraniliprole) azinphos-methyl (Guthion) Ambush, Pounce (permethrin) bifenthrin (Capture) Ammo (cypermethrin) carbaryl (Sevin) Apollo (clofentezine) carbofuran (Furadan) Asana (esfenvalerate) chlorantraniliprole (Altacor/Coragen) Avaunt (indoxacarb) chlorpyrifos (Dursban, Lorsban) AVID (avemectin) chlorethoxyfos (Fortress) Baygon (propoxur) clofentezine (Apollo) Baytex (fenthion) clothianidin (Belay, Clutch, Poncho seed treatment) Baythroid, Baythroid 2 (cyfluthrin) cyfluthrin (Baythroid) Belay, Clutch (clothianidin) cyhalothrin (Warrior) Capture (bifenthrin) cypermethrin (Ammo) Cruiser (thiamethoxam), deltamethrin (Decis, Delta Gold) Cygon, Dimethoate, Rebelate (dimethoate) diazinon (Diazinon, Sprectracide) Cythion (malathion), low volume dichlorvos (DDVP, Vapona) DDVP, Vapona* (dichlorvos) dimethoate (Cygon, Dimethoate, Rebelate) Decis, Delta Gold (Deltamethrin) emamectin (Proclaim) Delegate/Radiant (spinetoram) esfenvalerate (Asana) Diazinon (diazinon, diazitol, basudin, spectracide) ethyl parathion (Parathion) Dibrom (naled) fenpropathrin (Danitol) Dimecron (phosphamidon) fenthion (Baytex) Dursban, Lorsban (chlorpyrifos) hexythiazox (Savey/Onager Envidor (spirodiclofen) imidacloprid (Admire, Provado) Fortress (chlorethoxyfos) indoxacarb (Avaunt) Furadan (carbofuran) malathion (Cythion), low volume Fury, Mustang (zeta-cypermethrin) methamidophos (Monitor) Guthion (azinphos-methyl) methidathion (Supracide) Imidan (phosmet) methiocarb (Mesurol) Lannate (methomyl) methomyl (Lannate) Mesurol (methiocarb) methyl parathion (Penncap-M) Monitor (methamidophos) mevinphos (Phosdrin) Movento (spirotetramet) naled (Dibrom) Nexter (pyridaben) novaluron (Rimon) Orthene, Address (acephate) permethrin (Ambush, Pounce) Parathion (ethyl parathion, folidol, fosofex, thiophos) phosmet (Imidan) Penncap-M (methyl parathion) phosphamidon (Dimecron) Phosdrin (mevinphos)* propoxur (Baygon) Poncho (clothianidin) pyridaben (Nexter) Proaxis (gamma-cyhalothrin) resmethrin (Synthrin) Proclaim (emamectin) spinosad (Tracer) Rimon (novaluron) spinetoram (Delegate/Radiant) Savey, Onager (hexythiazox) spirodiclofen (Envidor) Scout (tralomethrin) spirotetramet (Movento) Sevin (carbaryl) thiamethoxam (Cruiser seed treatment) Spectracide (diazinon) tralomethrin (Scout) Supracide (methidathion) zeta-cypermethrin (Fury, Mustang) Synthrin (resmethrin) Tracer (spinosad) Warrior (lambda-cyhalothrin)

Moderately Toxic Pesticides

aldicarb (Temik) Acramite (bifenazate) - Moderate bifenazate (Acramite) - Moderate Actra, Platinum (thiamethoxam) carbaryl (Sevin XLR formulation only) Assail (acetamiprid) - Moderate carbophenothion (Trithion) Calypso (thiacloprid) - Moderate disulfoton (Disyston) Confirm (tmethoxyfenozide) - Moderate endosulfan (Thiodan) Counter (terbufos) ethoprop (Mocap) Disyston (disulfoton) fonofos (Dyfonate) Dyfonate (Fonofos) malathion (Malathion) Esteem

(pyriproxyfen) methoxyfenozide (Confirm) - Moderate Korlan (ronnel) methyl demeton (Metasystox) Larvin (thiodicarb) oxamy (Vydate) Malathion (malathion) oxydemeton-methyl (Metasystox R) Metasystox (methyl demeton) phorate (Thimet) Metasystox R (oxydemeton-methyl) pyriproxyfen (Esteem) Mocap (ethoprop) ronnel (Korlan) Oberon (spiromesifen) - Moderate spinosad (SpinTor) Sevin XLR (a specific carbaryl formulation) spiromesifen (Oberon) - Moderate SpinTor (spinosad) temephos (Abate) Temik (aldicarb) terbufos (Counter) Thimet (phorate) thiacloprid (Calypso) - Moderate Thiodan (endosulfan) thiamethoxam (Actara, Platinum) Trithion (carbophenothion) thiodicarb (Larvin) Vydate (oxamyl)

Relatively Nontoxic Pesticides

allethrin (Pynamin) Acaraben (chlorobenzilate) amitraz (Mitac) Beleaf (flonicamid)

azadirachtin (Neemix, Align) Belt (flubendiamide) Bacillus thurgingiensis or Bt (Biobit, DiPel, Full-Bac, Javelin, MVP, etc.) Benlate (benomyl) - F benomyl (Benlate) - F Biobit (Bacillus thuringiensis) binapacryl (Morocide) - F Bordeaux mixture - F Bordeaux mixture - F Captan - F captan - F Confirm (teufenozide) chlorobenzilate (Acaraben) Cyprex (dodine) - F chlorothalonil (Brazo) - F Dimilin (diflubenzuron) copper compounds (Kocide) - F Dipel (Bacillus thuringiensis) cyromazine (Trigard) Dithane (zineb) - F dicofol (Kelthane) Dithane M-22 (maneb) - F** diflubenzuron (Dimilin) Dithane M-45 (mancozeb) diodine (Cyprex) - F Dylox (trichlorfon) ethion (Ethion) Ethion (ethion) etoxazole (Zeal) Fulfill (pymetrozine) fenpyroximate (Portal) Full-Bac (Bacillus thuringiensis) flonicamid (Beleaf) Javelin (Bacillus thuringiensis) flubendiamide (Belt) Kelthane (dicofol) fluvalinate (Spur) Kocide (copper compounds) - F koalin (Surround) Marlate (methoxychlor) mancozeb (Dithane M-45) - F Mitac (amitraz) maneb (Dithane M-22) - F** Morocide (binapacryl) - F metiram (Polyram) - F MVP (bacillus thuringiensis) pymetrozine (Fulfill) Neemix, Align (azadirachtin) pyrethrum (nature) Omite (propargite) rotenone (Rotenone) Polyram (metiram) - F sulfur - F Portal (fenpyroximate) tebufenozide (Confirm) Pynamin (allethrin) trichlorfon (Dylox) Rotenone (rotenone) zineb (Dithane) Spur (fluvalinate) Sulfur - F Surround (kaolin) Trigard (cyromazine) Zeal (etoxazole)

BEE POLLINATION OF CROPS

Plants have sexes somewhat same as animal do. Many plants carry both the male and female elements on the same flower while other has sex organs on the separate Plants. These plants require to be carrying from one plant to another plant of some species or other species to effect pollination. The transfer of male reproductive element (pollen) on the stigmas of flower is termed as pollination. The transfer of pollen from another to stigmas of the same flower of same plant is termed as self, while those involving the transfer of pollen from an anther to the stigma of a flower of flower of another individual plant is termed as cross pollination. Reproducing of off springs without involving the union of sperm and egg cells such as in rhizomes, tubers, grafts etc. is asexual reproduction. But most flowering plants reproduce sexually. For sexual reproduction the transfer of pollen from the male part (anther) to the stigma of the female part is required. This transfer of pollen from anther to stigma can take place within a flower or flowers of same plant or between the plants of similar genetic make up (self-pollination). But in cross pollination the transfer of pollen from the anther of one to the stigma of another plant with different genetic make up takes place. Cross pollination is to the benefit of the population and plants have various mechanisms to favour it and avoid self pollination.

Cross pollination is brought about by external pollen transferring agents. A number of agents are necessary to effect pollination. These includes a biotic (wind, water, gravity etc.) and biotic (insects, bats, birds, snails and slugs etc.). Wind is the most important pollinating agent and many important crops like millets, maize, barley, wheat and rice are wind pollinated. Many types of animals also act as cross pollinators but amongst these, insects are important. Many wild bees are specialized for gathering nectar and pollen but some other insects such as flies, beetles and trips do visit the flowers to satisfy their own needs. These accidental visitors are poor or of no value pollinators except some species of flies. Of all the insects, true honeybees are by far the most important pollinators because their adults and young ones exclusively depend on ne4ctar and pollen, their body characteristics and foraging behaviour make them efficient pollinators and above all their population can be manipulated.

But among all of them, the insects are the most important with bees (Apis spp.) accomplish more than 80 percent of the pollination by insects. Honey and bees wax or other hive products are the direct visible benefits from a bee colony but the bees do manifold useful service and greater benefits are accrued by their contribution in increasing crop yields. The beekeepers do a great service to the community or village than for himself.

The value of bees of pollinator is first discovered by Koelreuter (1761), while knight first noted the relation between plants and hybrid vigor. Darwin's concept of natural selection opened the way for a fuller understanding of the correlation ship of bees and flowering plants, with resultant appreciation of factors affecting mutual adoption, speciation and distribution.

Honey bees (*Apis* spp.) are the most important pollinators of agricultural and horticultural crops. Honeybees have attributes that makes them valuable for crop pollination. These can be marshaled in adequate numbers at desired places. Their body parts are modified to effect pollination. Their body size and proboscis length suits them to forage many varied types of flowers. Their wide host range enables them to pollinate much type of crops. They work for longer durations and are also less effected by adverse climatic conditions as compared to other insect pollinators. Their foraging behaviour patterns are highly favourable to qualify them as most efficient pollinators of crops. In addition to pollination services, colonies can be managed to produce honey, bee was, porpoise, royal jelly etc. which are all saleable products.

Out of four Apis species available in India, only Apis cerana Fabr. And the exotic *Apis mellifera* L can be managed esaliy for crop pollination the two wild species, Apis florae L and Apis dorsata Faber. Can not be domesticated and are therefore are not easily manageable in pollination, however they are very important pollinators of may crops. Techniques now have been developed for the transport and placement of these bees at desired locations at desired time. The forage preference, pollinating efficiency and density of bee species vary depending on the crop. The number of foragers bee at on a particular crop at my moment of time is determined by the colony size, weather factors (temperature, wind velocity, relative humidity, solar radiation etc.) and floral attractiveness (colour, odour) and nectar and pollen concentration of flower.

Pollination requirements of crops have been attempted to be worked out in many crops. Use of honeybees for pollination is dependent on the natural pollinators already present in a locality but such pollinators are on the decrease due to advanced agricultural technologies and thus increased reliance on honeybees for pollination. Assessment of increase in yields due to bee pollination is difficult in some crops where the varieties are self-unfruitful. In such cases increases are unbelievable. Planned bee pollination is an input in crop husbandry in many parts of the world but in India this is receiving attention since any amount of effort in irrigation, fertilizers, plant protection etc. cannot compensate the good done by bee pollination. Following crops are benefited by bee pollination and yield can be increased by manifolds.

Table 1. Crops dependent/ benefited by bee pollination

Oilseeds	**Pulses**	**Fibre Crops**	**Fodder**
Rapeseed & mustard	Pea	Cotton	Berseem
Sesame	Cowpea	Mesta	Leucerne
Sunflower	Mung	Jute	Clover
Niger	Bean		
Linseed	Guar		
Vegetables	**Fruits**	**Condiment & Spices**	
Cabbage	Apple	Fennel	
Carrot	Pear	Methi	
Cauliflower	Peach	Chilles	
Onion	Plum	Cardmom	
Pumpkin	Mango	Cariander	
Watermelons	Cherry		
French beans	Ber		
Cucumber	Avocado		
Ash gourd	Citrus spp.		
	Pomegranate		
Plantation Crops			
Areca palm			
Coco palm			

Table.2. Effect of bee pollination on yield increase of crops

Crop Plants	Percent increase in yield	Crop Plants	Percent increase in yield
Oilseeds		**Fruits**	
Linseed	2-49	Apple	180-2600
Mustard	13-122	Pear	240-6,014
Sunflower	21-3400	Plum Litchi	6.70-2,739 4,538-10,246
		Orange	8.10-170
Beans		Grapes	23-54
Birds foot	3-1000	Guava	12-30
Clover	40-33, 150	Strawberry	17-92
Vetches	9.1-135.4		
Other Corps.		**Vegetables**	
Coffee	17-39	Radish	22-100
Cotton	12-50	Cabbage	100-300
		Carrot	9.10-135.4
		Onion	354-9878
		Muskmelon	756-6700
		Cucumber	21.10-411
		Squash	771.40-4800

Insect pollination is a requirement for the production of many crops, but in agro ecosystem native pollinators are often too scarce to ensure adequate pollination. Large scale monoculture, necessary for economic production of mechanically cultivated and harvested crops provides of mechanically cultivated and harvested crops provides no continual source of pollen and nectar necessary to maintain strong colonies. The indiscriminate and widespread uses of pesticides highly toxic to bees either weakens to destroy many colonies or their use causes the beekeepers to relocate the colonies in profitable area. Intensive agriculture has reduced honeybee population to a point where they are insufficient for pollination of commercial planting.

Management of honeybee for Pollination

1. Increasing the number of foragers

2. Attractants and sprayers

The purpose is to direct bees to crops. The bees perform recruitment dances and increase the numbers of bees visiting target crops, these includes

a) Scented sucrose solution

b) Food supplement sprays (eg. Beeline®)

c) Pollen attractant

d) Pheromones and other chemicals

3. Repellents

Repellents sprayed on the target crops reduce the bee forage and induce them to forage on the less attractive target crops e.g. carbolic acid, acetic acid, propionic anhydride, benzaldehyde, calcium chloride.

The mandibular glands pheromones, alarm pheromones can also be used.

4. Selection of breeding of honeybees

5. Management of honeybee colonies (moving colonies)

a) Timing: The colonies should be moved to a target crop blooms 5-10 percent, influence the number of foragers that are turn around it.

b) Distance from the crop: Placing the hive with in 0.5 km radius increases the crop pollination. Requirement of nest mates to the nearby sites is also greater as this information is more easily communicated. Colonies placed near crops collect more pollen and nectar, spend less time collecting load of pollen and nectar, the number of flights increases for both types with proximity to the floral source.

c) Number and placement: 3-5 colonies/hectare placed equidistant form each other within the crop is recommended. This number of colonies can be handled easily.

d) Replacement or Rotation: Colonies should be replaced or rotated with fresh ones when they begins to forage outside target crop. Colonies involved in these findings should be at least 2.4 kms apart or the bees may return to their former sites. This system is particularly useful, where the target crop e.g pear is relatively unattractive to bees.

d) Temporary placement: The flowers of crop generally present Their pollen/nectar at a certain times of the day. Thus confining the bees to their hive until to maintain bees, at least temporarily, on a crop.

Table : Number of hives needed per hectare

Crop	No of colonies recommended for pollination / ha
Oil Seeds	
Mustard	3-5
Sunflower	2-4
Fruits	
Apple	2-3
Pear	2-3
Peach	2-3
Plum	2-3
Khubani	2-3

Walnut	2-3
Citrus	2-3
Orange	4
Kiwi	8
Cherry	2-3
Litchi	3-5
Almond	2-4
Vegetables	
Cucurbits	2-3
Cauliflower	2-3

6. Removing floral competition

Weeds or other non target crops should be eliminated or mowed when in flower, to avoid competition for foraging bees.

7. Pollen Dispensers

Pollen dispensers (pollen inserts) apply pollen to bees leaving Hives so that they can cross pollinate when few pollinizers varieties are available. This may increase pollination efficiency of bees without necessarily maintaining more of them in a target crop. Dispensers may stimulates foraging activity and that may induce bees to forage for the type of pollen in the dispenser.

8. Disponsable Pollination Units (DPU's)

DPU's are small comb less colonies housed in inexpensive containers that are trucked or parachuted into target crops that are inaccessible, and then destroyed or left to die when flowering is over.

Conclusion

Considering the importance of bees on crop pollination, more coordinated research is needed. In India the total cultivated areas is 189 million hectares and at least 1/3 area is under entomophilous crops which require pollination. At a very modest rate of 3 colonies/ hectare, 567 colonies of honeybees are needed as against the merely the one million colonies at present. It is very necessary to survey and delineate different agro-climatic zones to determines the distribution can be supplement of pollinating agents so that regions must also carry out observations on the pollen gathering activities of bees. The lean pollen gathering period can be corrected by planting suitable pollen and nectar yielding flora of that period. Pesticides applications wherever possible can be modified as soil application instead of spray, can avoid drift to nearby hives. The selection and breeding of honeybees for physical characters suited crops, form reduced flight, or for preference for specific pollens or nectar appear promising.

Honeybees are the "angles or agriculture", the farmers best friend. Using honeybees for crop pollination, the production can be increased manifolds, however it needs to be encouraged among farmers. Pollination by bees has thus become a essential factors in producing many crops along with the factors that are taken for granted.

BEST MANAGEMENT PRACTICES (BMPS) FOR BEEKEEPING

A best practice is a method, process, activity, incentive, or reward which conventional wisdom regards as more effective at delivering a particular outcome than any other technique, method, process, etc. In beekeeping, like in most things, there is no one way of doing things that works best for everyone. There are, however, general guidelines for bee health that will likely provide useful for most beekeepers and will provide a good starting point for anyone getting into beekeeping.

Hive Maintenance

- Proper maintenance extends the life of the hive.
    - Check apiary for hive condition.
    - Inspect for rotten, loose or broken boards and frames.
    - Reconstruct, tighten or replace frame parts.
    - Paint supers with light colors to beat summer heat.
    - Take advantage of the winter months to do maintenance and prepare for the new season.
- Check bee attire.
    - Repair clothes, veil, gloves and bodysuit.
- Inspect essential two (2) pieces of equipment.
    - Smoker and the hive or "universal" tool.

Hygiene

- Practice good hygiene with hands, gloves, and other equipment to reduce transmission of pathogens between colonies.
    - Replace comb with new foundation to minimize residual chemicals in old wax.
    - Develop a comb replacement schedule.
    - Purchase equipment only if it has a history of clean health.
    - ID hives with a brand or name.

Exert you energy wisely

- Invest time, money and energy on your healthy colonies.
- Maintain a reserve; don't commit all your colonies to contract.

Monitor colony strength

- Cull weak colonies.
- Use diagnostic services for objective colony assessment.
- Check frames of brood for intended strength to coincide with almond bloom.
- Be mindful of colony placement to minimize stress.
- Do not combine weak collapsing colonies with healthy colonies.

Managing Stock

- Maintain genetic quality to meet your objectives:

- Maintain stocks that are productive and disease and pest resistant.
- Encourage high drone densities to provide well-mated queens and genetically diverse colonies.
- Discourage stocks that are excessively defensive.
- Select stock by propagating colonies that prosper when other colonies exhibit symptoms of stress.

- Requeen colonies, at least annually.
- Package bees typically exhibit low Varroa and virus levels during the year following installation. Consider making colony increases by shaking bees from colonies.

Water

- Consider water access when transporting colonies and when placing colonies in the orchard.

APPENDIX –I

HONEY BEES AND BEEKEEPING RESOURCES IN INDIA

Tiwana Bee Farm, Ludhiana

G. T. Road, Doraha District , Ludhiana - 141421, Punjab, India **Phone:**+91-9855082877 **Website:** http://www.indiamart.com/tiwana-bee-farm/

Swati Enterprises,

No. 144 A, Pocket A, Dilshad Garden , New Delhi - 110095, Delhi, India **Phone:** +(91)-8447580734 **Website:** http://www.hivehoney.in/

Chet Singh & Sons, Ludhiana

No. 14321, Bansal Complex, G. T. Road, Dholewall , Ludhiana - 141 003, Punjab, India **Phone:** +(91)-9953358191 **Website:** http://www.indiamart.com/chetsinghsons-inter/

Jonty Api Agro Services, Ludhiana

Village Landha Doraha, P. O. Bowani, Tehsil- Payal , Ludhiana - 141421, Punjab, India **Phone:** +(91)-9953353624 **Website:** http://www.indiamart.com/jonty-api-agro/

Spruce Impex, Bengaluru

Prasad Elegance, No. 2925/ A-16, West Of Chord Road, RPC Layout, Vijayanagar , Bengaluru - 560104, Karnataka, India **Phone:** +(91)-8588802426 **Website:** http://www.indiamart.com/spruce-impex/

Shiv Gramoudyog Sansthan, New Delhi

144-A, Pocket A, Dilshad Garden, , New Delhi - 110095, Delhi, India **Phone:**+91-9760785427 **Website:** http://www.indiamart.com/shiv-gramoudyog/

Vaishno Apiery & Farms, Rajpura

No. 2485, Gurudwara Road , Rajpura - 140 401, Punjab, India **Phone:**+91-9417014664 **Website:** http://www.indiamart.com/vaishnobee/

E. F. G. C Biological Farm, Chennai

No. 12, Rajiv Gandhi St, Pudu Nagar, Sembakkam, Selaiyur , Chennai - 600073, Tamil Nadu, India **Phone:**+91-9841050898 **Website:** http://www.indiamart.com /efgcbiologicalfarm/

Ambrosia Natural Products (India) Pvt. Ltd

47 -A, Satyam Enclave, Jhilmil, Near Vivek Vihar, Delhi - 110095, Delhi, India **Phone:** +(91)-8376807230 **Website:** http://www.ambrosianaturalhoney.com/pure-honey-beekeeping-equipment.html

L. I. I. Exports Pvt. Ltd.

No. 1/ 1- B, 2nd Floor, Het Ram House Building, Near Mata Mandir, New Friends Colony, New Delhi - 110025, Delhi, India **Phone:** +(91)-8588859697 **Website:** http://www.indiamart.com/liiexports/beekeeping-equipment.html

S. K. International

Mohalla Banjaran, P. O. Nakur, District Saharanpur, Saharanpur - 247001, Uttar Pradesh, India **Phone:** +(91)-9990669953 **Website:** http://www.indiamart.com/skinternational/

M V Export

C-53/54, Bais Godam Industrial Area, Jaipur - 302006, Rajasthan, India **Phone:** +(91)-8586975320 **Website:**http://www.indiamart.com/mvexport/bees-protective-clothings-tools.html

iddhi International

Sonamukhi Nagar, Sangaria Fanta, Jodhpur - 342 005, Rajasthan, India **Phone:** +(91)-291-2764488 **Website:**http://www.indiamart.com/riddhi-int/

Jai Bharat Nursery

Gm. Dandi, Near Rani Pokhari Dehradun Rishikesh Highway, Dehradun - 248001, Uttarakhand, India **Phone:** +(91)-9415276605 **Website:**http://www.indiamart.com/jai-bharat-nursery/

S. M. Exports, Kolkata

No. 61/ A, Mateshtala Road, Kolkata - 700046, West Bengal, India **Phone:** +(91)-9830244442

VITCO Beekeeping Supplies

3493, D. C ROAD Ambala Cantt, Harayana, India. Zip: 133001;

Telephone: 91-171-4009821 Mobile Phone: 9416020325

Fax: 91-171-2644593

APPENDIX –II

WEBSITES FOR TECHNICAL INFORMATION ON APICULTURAL DEVELOPMENT AND BEEKEEPING

Bees for Development
http://www.beesfordevelopment.org/
including
What We Do Information Centre>Beeswax Journal Online Book Store

International Bee Research Association
http://www.ibra.org.uk/
including
Journals Shop Information Services
Apiservices
http://www.apiservices.com/_menus_fr/index.htm?menu.htm&0
including
Apishop Country info Articles / Reports Databases

Mid-Atlantic Apiculture Research and Extension Consortium (USA)
http://maarec.cas.psu.edu/

Bee Culture
http://www.beeculture.com/index.cfm
including
McGregor's Handbook of Pollination *Bee Culture's* Online Book Store
The Science of Beekeeping Apis Information Resource Center
Cornell Pollination Study, by Roger Morse and Nick Calderone

Canadian Honey Council
http://www.honeycouncil.ca/index.php
including
Beekeeping Industry Facts and Information/Diseases and Pests
/Beekeeping in the Developing World

Australia
http://www.honeybee.org.au/pdf/wonderfull01.pdf
http://www.agric.wa.gov.au/index.htm